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(2004/2006)

# HERBERTIA

Journal of

The International Bulb Society • Volume 59 & 60



2004-2005 2005-2006



# HERBERTIA

Journal of the International Bulb Society

VOLUME 59  
2004–2005



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**Cover Photo:** *Pancratium tenuiflorum*

Photo by Connall Oosterbroek.

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ISSN 1559-8772

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Participation in occasional rare bulb sales. This will permit members to obtain rare and desirable species not available anywhere else.

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## EDITOR'S COMMENTS

After a long hiatus, *Herbertia* has surfaced again. As you can see, this is a double volume issue; it is an attempt to help recover the publication time that has been lost. You are invited to review the "expiration date" that is printed above your name on the mailing label (Expires end of Publication Year 20xx). In partial compensation for our delays in publishing, everyone who was a member as of last September (and every institutional subscription) received an extra year of membership as gratis — and this is reflected in your individual "expiration date." Publishing a double volume also saves the Society the expense of mailing two separate issues — journal-mailing expenses incurred for international members currently equal the journal publication costs. A postal category of "surface mail" delivery no longer exists, so this membership option is no longer available regarding memberships. Dues do not cover expenses, which is one reason why we are attempting to raise operating monies through donations received via the Seed and Bulb Exchange (SX/BX) that is operated on the IBS E-mail Forum (IBSMEMBERS).

I would like to briefly address my basic editorial philosophy. I inherited the Editor's position in mid May, only a few months ago. I will do my best to restore *Herbertia* back onto a regular publishing cycle. It is my intent to follow closely the basic guidelines of Dr. Hamilton Traub, the Society's founder, and I am quoting him: "The editorial policy of the Year Book is to publish timely articles but without too much formality. The Year Book will be at all times of, for, and by the members of the Society. However, when necessary to establish fundamental facts, entirely technical papers will be published." The opening paragraph in the "Guidelines for Contributors" near the back of the journal indicates the general types of articles that will be encouraged and accepted. So please, a journal cannot exist without contributors — and that's you.

A few brief comments about the contents of Volume 59 are in order. The 2004 Herbert Medalist, Floris Barnhoorn, is the son of a previous Herbert Medalist, Floor Barnhoorn — if you have a copy of *Plant Life* Vol 32, 1976, you may wish to compare pictures of father and son. This is the first father-son Herbert Medal pairing in the Society's history. (There was a previous mother-daughter pairing of Herbert Medalists: Mrs. Morris W. Clint in 1957 and Mrs. Marcia Clint Wilson in 1984.) The 2005 Herbert Medalist, Herbert Kelly Jr., current IBS President, Director of the Seed and Bulb Exchange, and Director of Awards Committee, considers Dr. Traub to have been a mentor as well as being a close personal friend. Dr. Charles Gorenstein, the 2005 Traub Awardee, is a former IBS Board Member, having managed the IBS Seed Exchange for many years and having organized the initial IBS Website. Then for your enjoyment and perusal, you will find articles on *Hippeastrum*, *Hymenocallis*, *Cyrtanthus*, *Crinum*, Brazilian *Amaryllidaceae*, *Allium*, *Rhinopetalum*, and *Zephyranthes*.

—David J. Lehmiller, Editor



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## THE HERBERT MEDAL



The Herbert Medal is the highest honor that the International Bulb Society can bestow upon a person for meritorious achievement in advancing the knowledge of bulbous plants. The medal is named for William Herbert (1778-1847), son of Henry Herbert, Earl of Carnarvon. William Herbert had a predilection for amaryllids and achieved success in their hybridization. He published his research findings in several monumental works. His contributions as a pioneer geneticist and plant breeder, and his arrangement of the Amaryllidaceae, helped set the stage upon which other workers, both amateur and professional, have been able to advance.

The Herbert Medal may be awarded annually or on special occasions by the Board of Directors of the Society. Candidates for the Medal are recommended to the Board of Directors by the Awards and Recognition Committee. Medalists need not be members of the Society to be considered for the Herbert Medal. The award includes honorary life membership in the Society.

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| 1950 Mrs. Mary G/ Henry, Pennsylvania    | 1976 Mr. Floor Barnhoorn, South Africa    |
| 1951 Mr. Mulford B. Foster, Florida      | 1977 Mrs. Emma D. Menninger, California   |
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## PAST HERBERT MEDALISTS (cont'd)

|                                         |                                         |
|-----------------------------------------|-----------------------------------------|
| 1979 Mr. Harry Blossfeld, Brazil        | 1992 Mr. Brian Mathew, England          |
| 1980 Mr. Charles D. Cothran, California | 1996 Dr. Maurice Broussard, France      |
| 1981 Mr. W. L. Tjaden, England          | 1997 Sir Peter Smithers, Switzerland    |
| 1982 Walter & Hilda Latapie, Louisiana  | 1997 Dr. Dierdre Snijman, South Africa  |
| 1983 Mrs. A. C. Pickard, Texas          | 1998 Dr. Alan W. Meerow, Florida        |
| 1984 Mrs. Marcia C. Wilson, Texas       | 1999 Mr. Fred Meyer, California         |
| 1985 Dr. Hamilton P. Traub, California  | 1999 Dr. Peter Goldblatt, Oregon        |
| 1988 Dr. Thomas W. Whitaker, California | 2000 Dr. A.A.De Hertogh, North Carolina |
| 1988 Mr. Grant E. Mitsch, Oregon        | 2000 Dr. David J. Lehmler, Texas        |
| 1988 Mr. L. S. Hannibal, California     | 2001 Mr. Graham Duncan, South Africa    |
| 1990 Dr. H. Shuichi Hirao, Japan        | 2002 Dr. Marcel Le Nard, France         |
| 1991 Dr. Kenneth E. Mann, California    | 2003 Dr. Harold Koopowitz, California   |

2004 HERBERT MEDALIST

FLORIS BARNHOORN



## FLORIS BARNHOORN

### AUTOBIOGRAPHY

I was born in the town of Sassenheim on May 10, 1943, the first of five children. Sassenheim was a small town in the centre of the traditional flower-bulb-growing district of Holland and a stone's throw away from the famed Keukenhof Flower Bulb Display Gardens. The Barnhoorns for many generations had been farmers and bulb growers in this district.

My late father grew up in this area and after leaving school at the age of 14 (times were hard after the 1<sup>st</sup> World War), he started work in the bulb fields. He soon progressed to being a buyer or "commission agent." In the dark days before the advent of the 2<sup>nd</sup> World War, my father started dreaming of having his own flower bulb farm, and he realized that his best chance to achieve this ambition would be to move to South Africa, the natural home of many bulb species.

When my father first mooted this scheme to his girlfriend just before the outbreak of the 2<sup>nd</sup> World War, her response was: "You go on your own. I'm not going to emigrate to Darkest Africa." So the idea was kind-of-dropped, and they were married in 1942. In 1943 I came along, and 3 years later in 1946 there were 4 children (one set of twins was involved!).

So, the idea of emigration to Darkest Africa was resurrected. My mother of course now had little choice! The move was made in 1948. A Company was set up between 4 partners and was named the "Harry Deleeuw Company" after the partner who handled sales and administration. My father busied himself with production and breeding.

It was realized from the start that there was a great potential in the idea of growing specific bulbs in the Southern Hemisphere and sending them to the Northern Hemisphere in the "wrong" (or opposite) season so that they would flower out of season. One such potential was *Hippeastrum* or "Amaryllis" as we commonly called them. By growing these in the Southern Hemisphere summer (September to May), they could be harvested during the Southern Winter (May through August) and transported to the Northern Autumn to be potted up and be ready to bloom during the fall, the winter and over the Christmas period.

Soon *Hippeastrum* hybrid bulbs were imported from Holland and species were obtained from South America as well as a feral South African form that had apparently "escaped" from a collection of an early colonial

official to Africa. A breeding program was started as the intention was (and still is) to market only our own exclusive range of cultivars or our own “brand” of “Amaryllis.”

I was a boy aged five when the family emigrated from Holland to South Africa. We had moved from a smart house on the main street of a quaint clean Dutch village to a two-roomed shack in the sticks, 30 miles from Johannesburg, reachable only by an unpaved, muddy road. There was neither electricity nor running piped water. The “long-drop” lavatory was 50 yards from the front door in one direction and the bathroom 50 yards away in the other direction. There were snakes in the grass and monkeys in the trees. My mother had to cook on a “primus” stove. She hated it. The kids loved it. My father promised her that he would take her back to Holland to visit after four years. He promised that if after four months there she wanted to stay, they would all move back to Holland and forget the whole deal. After four years we went back on holiday, and guess who wanted to go back to Africa after a few weeks? My mother!

South Africa in those days was everything a growing boy could want in life. I grew up in a carefree, barefoot, outdoor, sun drenched paradise marred only by having to attend school every day from 8 am till 2 pm. School was 15 miles away by bus. The bus often became stuck in the mud caused by heavy summer thunderstorms. Unfortunately this tended always to happen on the way back from school, as there was a particularly steep hill to negotiate. I did not like school. I yearned for the outdoors every single day of my school life. I was often berated for staring out of the windows, dreaming.

I graduated from High school at age 17 in 1962 and started my career in the company. The first year I was shunted between all the outdoor growing operations in which every department was busiest at the time. My father was of the opinion that two things were very important in this stage of a youngster’s life: 1) You had to learn to work; and 2) You had to start at the bottom.

When I was 19 years old, Dad packed me off to work in Germany for a year. This was so I could learn: 1) What it’s like to work for someone else; and 2) To make me independent. Here I worked in a well-known wholesale seed and bulb packaging and distribution company which employed about 60 young girls amongst its staff. After 10 months, when my time was running out, I wrote home and asked Dad if I could spend another year away to learn more. I mentioned Sweden. I was turned down.



When I returned back home, I was enrolled as assistant salesman and spent much of the next year selling bulbs in South Africa. Although I gradually became more and more involved in the sales and admin side of things, I have always had a keen fascination with the breeding of *Hippeastrum* and have throughout been deeply involved in steering the hybridizing work in directions I thought exciting and new.

I testify with absolute confidence that both my staff and my wife will unhesitatingly classify me as a person difficult to please. To have a constant quest for perfection and to be never satisfied with the status quo is often not easy for the people around you. My most exciting time of the year is when the new batch of hybrids flower for the first time. There is nothing like the joy of seeing a new possible star. I also see our hybridizing program as an investment in the future.

I can remember when I was a youngster that we had only mixed hybrids to offer. We had "red hybrids" and "pink hybrids" and so on. It was in 1957 that the first real break-through was made with the cultivar "Zanzibar." This was ready for marketing from 1963 onwards and is the only cultivar of this era still available today, although it is now also, sadly on its way out to make room for superior offerings.

These days we are hybridizing at an ever-increasing scale, mainly as a result of the diversity of "Amaryllis" having become so much broader. In the old days we only had the large flowered types. In 1997 we introduced the concept of three size classifications. This had become necessary because of the introduction of "Amaryllis" which had smaller size blooms than the conventional types available. Now we have a whole range of types and these now look to be officially classified by the Dutch K.A.V.B., broadly into:

Symphony = Large flowered  
 Sonata = Medium size blooms  
 Sonatini = Small size blooms  
 (and perhaps) Solo = Very small blooms.

Exact flower sizes are to be determined and are under review. We are very excited about these new developments which we are sure are going to revolutionize the "Amaryllis" world.

A range of cultivars in the Sonata and Sonatini classes is already available, in some instances also in double flowering forms. The Solo range (tiny blooms) is under development, and we are very excited about these as we envisage these not only for multiple pot-planting use (the bulbs are often the size of a golf or ping-pong ball!) but also for mass garden planting in

milder climates.

In addition there will be several other divisions as much work is presently being done with *Hippeastrum cybister* and various other species to create new flower forms, as well as other new departures.

Since my early years in this game, I have stuck to a set of rules or desirable traits to look for. We have not deviated from these, except in the past 15 years or so in the work on small flowering and miniature flowing cultivars of *Hippeastrum*. The basic requirements for a successful new clone are (not in sequence of importance):

1. High number of blooms per stem, and high number of stems per bulb.
2. Good proportion between bloom size, stem length and foliage length.
3. Ease of growing (both for commercial grower and end-user).
4. High resistance to disease.
5. Firm skinned bulbs with strong root systems.
6. Good color definition and quality.
7. Strong stems.
8. Long lasting blooms.
9. Well formed blooms.

This year we are twin-scaling 50,000 large bulbs, all of newest clones, which should give us 2,000,000 large bulbs back in 2 years time.

Anyway, let's get back to the story. It was in 1964 that I got my real lucky break in life. I met Hilary. We were married in 1966. Our two children, Stuart (1969) and Charles (1975) are both actively involved in Hadeco and both are most enthusiastic about carrying on the traditions of the past whilst at the same time moving the company forward into the future. In April 1999 I bought out my two brothers, Daniel and Andre, who were co-shareholders with me until then.

If I look back at how we used to do things in the past and compare that to the methods of today, I am always amazed at the progress we have been able to make. I remember packing huge wooden crates with "Amaryllis" and manually hauling these first on to trucks, then from the trucks on to railway wagons, off-load manually at the docks and loading them manually one-by-one into the cooler holds of the ships to take them across the ocean to Europe and the States. Today the crates are much lighter and smaller, we have assembly belts for packing, we have forklift trucks, and above all, we pack straight into high tech, temperature and humidity controlled, integral (own power unit) reefer containers. We have also had our share of hassles

with politics in the past and still do at present.

It was during October 1986 that the USA as well as the Nordic countries of Sweden, Denmark, Norway and Finland declared economic sanctions against South Africa because of the practice of "apartheid" here. This forced us to do some fast thinking and planning. In those days all our "Amaryllis" bulbs destined for export to the USA went by airfreight. The only carrier to fly to the USA from South Africa was South African Airways (SAA). The USA Government revoked SAA's licence to operate to New York overnight during October 1986. We had our last consignment of that season (8 tons) on the very last flight out of Johannesburg to New York. But what to do for the next year and there after? We registered a company in the small neighboring country of Swaziland, called it Swazibulb and set up a growing operation in that country. This enabled us to process all our documentation and product as origin of Swaziland. What we lost was our USDA pre-inspection program. We have been operating ever since without pre-inspection. Sanctions also forced us to find alternative transport means. We made it work although it was complicated and expensive. Our now "Swaziland" product was air freighted by Air France Boeing 747 freighters from Johannesburg to Paris, France - 50 tons at a time - then transferred onto trucks and road transported the 270 mile journey from Paris to the sea port of Rotterdam. At Rotterdam the goods were loaded into 40' reefer containers and sea-shipped to New York.

Although those problems are now in the past, we have a new set of problems to cope with - the "new" South Africa of "reverse apartheid." We now have "affirmative action" which favors jobs and contracts to black people over white people. We have R.D.P. (Reconstruction and Development Program), which is designed to do much the same thing. We have militant unions and unworkable labor laws. We have wholesale theft and car hijackings, strikes, taxes on water use, land grabs, and more. But we are still here, growing some 100 million bulbs (42 different kinds) and some 40 million cut flower stems (12 different kinds) per annum, all produced in-house by Hadeco on seven "farms." We have about 600 acres under cultivation, and we employ a permanent staff of 700 and seasonally up to 800 part-timers on top of that.

It is our aim to keep improving on perfection of product especially in "Amaryllis" breeding. To do this we need to work with as many species as possible. There are academics who believe that species should be left in the wild or at most be collected and held only by amateur collectors and not fall



into the hands of commercial entities. This is a dangerously misguided philosophy. The best (and in some instances, the only) way to preserve or even re-introduce endangered species, is to let professional growers and hybridizers hold and multiply stocks, much the same as is being done with the giant panda and black rhinoceros and other endangered species around the globe.

#### ACCOMPLISHMENTS

##### HIPPEASTRUM CULTIVARS INTRODUCED:

- Summertime® (1980).....Symphony type, Nyron Rose HCC 623.  
 Wedding Dance® (1980)...Symphony type, Pure white.  
 Intokazi® (1981).....Symphony type, Pure white.  
 Sundance® (1982).....Symphony type, Vermillion HCC 18.  
 Carnival® (1983).....Symphony type, Cardinal red HCC 822.  
 Miracle® (1985).....Symphony type, Cardinal red HCC 822, velvety sheen.  
 Candy Floss® (1986).....Symphony type, Spiral rose HCC 625, greenish white throat.  
 Merry Christmas® (1986)..Symphony type, Orient red HCC 819.  
 Blushing Bride® (1987).....Symphony type, Rose Madder HCC 23/2, streaked white.  
 Honeymoon® (1987).....Symphony type, Cherry HCC 722/2.  
 Midnight® (1989).....Symphony type, Cardinal red HCC 822.  
 Double Six® (1991).....Symphony type, Signal red HCC 719.  
 Ragtime® (1993).....Symphony type, Double flowering, Orient red HCC 819.  
 Razzle Dazzle® (1995).....Symphony type, Signal red HCC 719, white striped.  
 Rio® (1996).....Symphony type, Double flowering, Vermillion HCC 18, streaked white with white center.  
 Rozetta® (1997).....Symphony type, Double flowering, Nyron rose HCC 623, with greenish white throat and petals, streaked.  
 Veneto® (1997).....Sonatini type, Salmon pink, streaked white.  
 Pizzazz® (1998).....Sonatini type, Signal red HCC 719, white star center.  
 Snow White® (1998).....Symphony type, Double flowering, Pure white.  
 Razzmatazz® (1998).....Symphony type, Double flowering, Vermillion HCC 18, prominent white bands in petal centers.  
 Joker® (1998).....Sonata type, Signal red streaked over white background.  
 Christmas Star® (1999).....Sonata type, Fire red with white centre.  
 Alfresco® (1999).....Sonata type, Double flowering, Creamy white.  
 Amico® (1999).....Sonatini type, Dark red with white brushed centre.



- Virgin® (1999).....Symphony type, Pure white.  
 Top Choice® (2000).....Sonata type, Orient red HCC 819.  
 Amalfi® (2000).....Sonata type, Delft rose HCC 020/1, green centre  
 surrounded by small white star.  
 Piccolo® (2000).....Sonatini type, Red-white center.  
 Pico Bello® (2000).....Sonata type, Porcelain rose HCC 620, White centre.  
 Fanfare® (2001).....Sonatini type, double flowering, Signal red.  
 Bambino® (2001).....Sonatini type, Vermillion HCC 18,  
 Gold Medal® (2002).....Symphony type, Signal red HCC 719, White star  
 centre.  
 Trentino® (2002).....Sonatini type, White with red edges.  
 Vegas® (2003).....Symphony type, Double flowering, White with red centre.  
 Super Star® (2004).....Symphony type, Cardinal red HCC 822.  
 Hollywood® (2004).....Symphony type, Delft rose HCC 020/1.  
 Rock 'n Roll® (2004).....Symphony type, Double flowering, Orient red  
 HCC 819, with white centre.

#### **BOOKS PUBLISHED:**

1. Barnhoorn, F. 1995. Growing Bulbs in Southern Africa. ISBN  
 1868125645.
2. Barnhoorn, F. 1997. Growing Bulbs in Southern Africa.  
 [Afrikaans translation]

#### **OTHER:**

1. 1985-1989. Chairman of South African Flower Growers Association.
2. Published many articles and editorials in gardening magazines and  
 periodicals.
3. Hosted numerous radio and TV programs on growing flower bulbs.

**2005 HERBERT MEDALIST**

**HERBERT KELLY JR.**



## HERBERT KELLY JR

## AUTOBIOGRAPHY

I was born on March 11, 1944 in Fresno, California. During my early years I lived with my Armenian grandmother and grandfather, Zabel and Solomon Shaterian. Consequently I learned to speak Armenian before English. My grandfather grew fruits and vegetables for a living. I was always following grandfather in the rows as he planted the young vegetable plants; often he would allow me to place one in the ground as he smiled. Grandmother loved gardening, and she had many fantastic plants growing in her garden. It was in this setting where I was exposed to gardening and acquired my love for plants. I admired the large flowering hybrid *Hippeastrum* in many colors, the pink *Amaryllis belladonna* (so deliciously fragrant), the wide variety of ornamental trees and shrubs, *Daubentonia tripettii*, and *Althaea* in many different colors including both single and double forms. Roses of every color hue imaginable abounded in grandmother's garden. Morning glories in shades of red, white and blue climbed to the top of our old pump house. There were Japanese flowering Quince which I looked forward to seeing every year in orange-red, white and pink forms. Pomegranates, with their beautiful carnation like, reddish- orange blossoms, were always a nice surprise. Many of these plants are still my favorites today.

As I grew older and began attending grammar school at West Park Elementary School, I read about the "Legendary-Plant-Wizard Luther Burbank." Needless to say, I was inspired by his accomplishments, and I decided that I must follow in his footsteps — I had chosen my path in life.

One day while in grandmother's garden, I pollinated an *Amaryllis belladonna* with the pollen from a red hybrid *Hippeastrum*. My grandmother saw this and inquired: "What are you doing?" I said: "I'm going to make new flowers and plants like Luther Burbank," and I explained how I had read about him in books at the library.

So began my life's work. I had a dream to one day leave this world a nicer place, because of my having lived. I wanted to walk where no man had walked before. I would hopefully accomplish this feat through the new plants I would create and introduce to the gardening world. This dream was to be my legacy. I graduated from McLane High School in 1962, and



then on June 21, 1963, I married Pamela Paldi, with whom I had attended high school. We had three children, Timothy, Susan and the last was Catherine (who arrived in 1975). In 1963 I took an evening course in horticulture for one year at Fresno City College, where I studied plant identification and landscape design. In 1964 I began attending law enforcement classes at Fresno City College. In 1965, after one full year of classes, I made a decision that law enforcement was not to be my life's profession.

I still maintained my passionate love for plants, and this became very serious about 1965. I began to acquire rare trees, bulbs, shrubs, etc., from around the globe. My hybridizing work continued, and my plant collections soon became massive. By then, I had many new creations from my hybridizing. In 1970, I decided to open Kelly's Plant World to distribute many of my botanical treasures. I began distributing many of my plants to mail order nurseries, botanical gardens, and parks around the world. Many hobbyists and gardening enthusiasts also desired my plants, which they acquired as they were propagated. By 1999, I had introduced almost 150 new plants into horticulture.

It was in 1970 that I first met Dr. Hamilton P. Traub (now deceased), founder of the American Plant Life Society, and antecedent of the International Bulb Society (IBS). In a short time we became close friends. He was the most positive, encouraging person that I had ever met. Through Dr. Traub, I felt I could accomplish anything in life I desired. His encouragement and motivation drove me forward like nothing I had ever known. It was here in the American Plant Life Society (now the International Bulb Society), that I became acquainted with many additional outstanding people who influenced me in many ways, including: William T. Drysdale, Dr. Thad M. Howard, Dr. David J. Lehmler, Dr. Kenneth E. Mann (deceased), and Dr. Alan W. Meerow.

The following three people also influenced me in many ways. They all inspired me to go forth and create. They showed me that there was no obstacle in life that could stop one from accomplishing his dreams. (1) Luther Burbank (deceased), of Santa Rosa, California — his greatest contributions were not all the new plants he created and introduced, but the fact that he inspired many to go forth into the horticultural world and create. (2) William H. Henderson (deceased), apprentice to Luther Burbank, and owner of Henderson's Experimental Gardens, Fresno, California — Bill Henderson was never too busy to answer the continual questions of my inquisitive mind. I rode my bicycle to his gardens 3 to 4 times a week to



look at his plants and to ask questions. (3) Bill Wilson (deceased), propagator for Henderson's Experimental Gardens, also played a great part in my life's development. Bill taught me many new procedures of propagating and grafting, which he had learned from Henderson. He constantly encouraged me to continue my work. I will never forget a day in December when I became ill; upon hearing this, Bill came to my home and spent a day and a half finishing all my grafting projects for me. He was a kind, caring, and generous man.

I will be forever grateful for the sharing of plants, knowledge, friendship, loyalty, and the motivation the members of the American Plant Life Society and the International Bulb Society have instilled in me. Many of you are gone, but your plants and memories will live on within me. Thank you, for being the best part of my life, and for helping me to become the person I am today — and for showing me how to believe in myself. You have had a profound effect on my life.

#### PUBLICATIONS:

1. Kelly, H. Jr. 1983. In memoriam, William H. Henderson. *Plant Life* 39:55-59.
2. Kelly, H. Jr. 1983. The origin of *Crinum* x Clone 'White Queen' (Burbank-Henderson, 1930). *Plant Life* 39:66-78.
3. Kelly, H. Jr. 1983. *Crinum* x Clone 'Royal White' (Henderson, 1937). *Plant Life* 39:78-80.
4. Kelly, H. Jr. 1984. The Dr. Hamilton P. Traub I knew. *Plant Life* 40:25-27.
5. Kelly, H. Jr. 1984. A *Crinum* of unknown origin. *Plant Life* 40:70-77.
6. Kelly, H. Jr. 1986. Major color breakthrough in hybrid *Crinum*. *Plant Life* 42:71-74.
7. Kelly, H. Jr. 2005. The elusive *Hymenocallis euchardifolia*. *Herbertia* (in press).

#### PLANT INTRODUCTIONS:

1. *Abutilon* 'Mida's Touch' - Orange flowers, variegated foliage.
2. *Aesculus californica* 'Pink Passion'
3. *Albizia julibrissin* 'Red Waves'
4. *Althaea* Rose of Sharon variegated
5. *xAmarcrinum* 'Ambiance' - White /lavender edge.
6. *xAmarcrinum* 'Born Free' - White, slight hint of pink in cool weather.
7. *xAmarcrinum* 'Elegance' - Ivory white, wide petals, slight suffusion of

pinkish coloration, and a delightful spicy fragrance.

8. *xAmarcrinum* 'Hamilton P. Traub' (H. P. Traub introduction, named and introduced after his death, by Herbert Kelly Jr.)
9. *xAmarcrinum* 'Pinkie' - Dark pink.
10. *xAmarcrinum* 'Scentsational' - Pinkish.
11. *xAmarcrinum* 'Pink Splendour' - Pinkish.
12. *xAmarcrinum* 'Sweet Surrender' - Pinkish.
13. *xAmarcrinum* unnamed
14. *xAmarcrinum* unnamed
15. *Amaryllis belladonna* - Pinkish intraspecific hybrids, over 50 different
16. *Amaryllis belladonna* - White intraspecific hybrids, over 50 different
17. *Amaryllis belladonna* - Reddish intraspecific hybrids, over 50 different
18. *Amaryllis belladonna* 'Ambiance' - White/lavender tips on tepal segments, elegant blossoms.
19. *Aspidistra elatior* 'Kelly's Improved' - Green leaves.
20. *Aspidistra elatior* variegata 'Kelly's Stripes'
21. *Bauhinia forficata* 'White Doves'
22. *Bauhinia purpurea* 'Purple Sensation'
23. *Bletilla ochracea* 'Lemon Mist'
24. *Bletilla ochracea* 'Mellow Yellow'
25. *Bletilla ochracea* 'Yellow Fever'
26. *Bletilla striata* - Pinkish sport.
27. *Bletilla striata* 'Pink Sensation'
28. *Canna* 'Afterglow'
29. *Canna* 'Carousel'
30. *Canna* 'Confetti' improved
31. *Canna* 'Fiesta'
32. *Canna* 'Glowing Embers' - Purplish leaves and glowing orangish-red blossoms
33. *Canna* 'Grande' improved
34. *Canna* 'Intrigue'
35. *Canna* 'Orange Splash' - Medium size pastel orange flowers.
36. *Canna* 'Panache'
37. *Canna* 'Pinkie' - Tiny species type, pinkish flowers.
38. *Canna* 'Purple Sentinel' - Lance shaped purplish/green foliage, tall.
39. *Canna* 'Red Baron' - Reddish leaf with highlighted red stripes.
40. *Canna* 'Red Sentinel' - Cleopatra sport.
41. *Canna* 'Red Stripes' improved

42. *Canna* 'Red Velvet'
43. *Canna* 'Satans Torch'
44. *Canna* 'Summer Glow'
45. *Canna* 'Tahitian Sunset'
46. *Canna* 'Tiger Moth'
47. *Canna* 'Yellow Glow' (Longwood C. x Ra x C. x Halloween)
48. *Canna* 'Yellow Sensation' - Yellow species type.
49. *Cassia* Species (Possibly *C. tomentosa*) - Selected seedling (Yellow Glow), blooms in Fresno, California in both summer and winter.
50. *Cedrus atlantica glauca pendula* sport - Long bluish green needles.
51. *Cedrus atlantica* sport - Small green needles like *C. brevifolia*.
52. *Chaenomeles japonica* 'Spring Bouquet'
53. *Chilopsis linearis* 'Grande' - Large pinkish flowers.
54. *Chilopsis linearis* 'Purple Splendour' - Rich purple flowers.
55. *Chilopsis linearis* 'Snowflurry' - White flowers.
56. *Chionanthus retusus* 'Snowflurry' - Chinese fringe tree.
57. *Chionanthus virginicus* 'White Clouds' - Fringe tree.
58. *Clivia* 'Afterglow' - Reddish colored flowers.
59. *Clivia* unnamed - Variegated leaves.
60. *Clivia* unnamed - Variegated leaves.
61. *Clivia* 'Midas Touch' - Variegated leaves.
62. *Crinum* 'Kelly's Carousel'
63. *Crinum* 'Mrs. James Henry' on *C. bulbispermum roseum*, seed parent.
64. *Crinum* 'Panache'
65. *Crinum* 'William Henderson'
66. *Crinum* 'Yellow Triumph'
67. *Crinum bulbispermum* album intraspecific cross
68. *Crinum bulbispermum* album intraspecific cross
69. *Crinum bulbispermum* album intraspecific cross
70. *Crinum bulbispermum* album intraspecific cross
71. *Crinum bulbispermum* album intraspecific cross
72. *Crinum bulbispermum* intraspecific cross; *C. Orange River bulbispermum* x *C. bulbispermum roseum* 'Cape Ambiance'
73. *Crinum bulbispermum* intraspecific cross; *C. Orange River bulbispermum* x *C. bulbispermum* 'African Sunrise'
74. *Crinum bulbispermum* intraspecific cross; *C. Orange River bulbispermum* x *C. bulbispermum* 'African Sunset'
75. *Crinum bulbispermum* intraspecific cross; *C. Orange River*

- bulbispermum* x *C. bulbispermum* 'Cape Rage'
76. *Crinum bulbispermum* intraspecific cross; *C. Orange River bulbispermum* x *C. bulbispermum* 'Cape Illusion'
77. *Crinum bulbispermum* intraspecific cross; *C. Orange River bulbispermum* x *C. bulbispermum* 'Cape Splendour'
78. *Crinum bulbispermum* intraspecific cross; *C. Orange River bulbispermum* x *C. bulbispermum* 'Cape Obsession'
79. *Crinum bulbispermum* intraspecific cross; *C. Orange River bulbispermum* x *C. bulbispermum* 'Cape Elegance'
80. *Crinum bulbispermum* intraspecific cross; *C. Orange River bulbispermum* x *C. bulbispermum* 'Cape Melody'
81. *Crinum bulbispermum* intraspecific cross; *C. Orange River bulbispermum* x *C. bulbispermum* 'Cape Ecstasy'
82. *Crinum bulbispermum* Orange River Basin form (UC Berkley Botanical Gardens, 1949)(seed parent) x *C. flaccidum* yellow (pollen parent) Multi colored flowers same umbel *C. 'Chameleon'*.
83. *Crinum bulbispermum roseum* intraspecific cross; *C. bulbispermum roseum* x *C. bulbispermum roseum*; select clones *C. 'Cape Mystery'*
84. *Crinum bulbispermum roseum* intraspecific cross; *C. bulbispermum roseum* x *C. bulbispermum roseum*; select clones *C. 'Cape Rapture'*
85. *Crinum flaccidum* yellow x *C. bulbispermum album* - White flowers, green leaves.
86. *Crinum flaccidum* yellow x *C. bulbispermum album* - White flowers, glaucous leaves.
87. *Crinum flaccidum* yellow x *C. bulbispermum* Orange River Basin - White flowers, glaucous leaves.
88. *Crinum* 'Fresno' x *C. americanum*
89. *Crinum* 'Fresno' x *C. amoenum*
90. *Crinum* 'Fresno' x *C. 'Bradley Giant'*
91. *Crinum* 'Fresno' x *C. bulbispermum roseum*
92. *Crinum* 'Fresno' x *C. bulbispermum roseum*
93. *Crinum* 'Fresno' x *C. 'Cape Dawn'*
94. *Crinum* 'Fresno' x *C. flaccidum*
95. *Crinum* 'Fresno' x *C. moorei*
96. *Crinum* 'Fresno' x *C. 'Mrs. James Henry'*
97. *Crinum* 'Fresno' x *C. 'Peach Blow'*
98. *Crinum* 'Fresno' x *C. scabrum*
99. *Crinum* 'Fresno' x *C. 'White Queen'* - Large, wide recurving-tepal segments.



100. *Crinum* 'Fresno' x *C. 'White Queen'* - Small recurving-tepal segments.
101. *Crinum* 'Fresno' x *C. zeylanicum*
102. *Crinum macowanii* intraspecific cross
103. *Crinum* 'White Queen' x *C. 'Cape Dawn'*
104. *Crinum* 'White Queen' x *C. flaccidum* yellow
105. *Crinum* 'White Queen' x *C. 'Peach Blow'*
106. *Crinum* 'White Queen' x *C. powellii* album
107. *Crinum x herbertii* 'Royalty'; *C. scabrum* x *C. Orange River bulbispermum*
108. *Crinum x powellii rubrum*; *C. bulbispermum* Orange River Basin form x *C. moorei* - Narrow petaled form, dark pinkish-rose flowers.
109. *Cryptomeria japonica* 'Kelly's Fastigiata'
110. *Diates* 'Ambiance' - Lemon drops hybrid, brown/spots white flowers.
111. *Diates* 'Elegance' - Lemon drops hybrid, yellow/spots purplish center.
112. *Erythrina bidwilli* 'Red Showers'
113. *Erythrina crista-galli* 'Red Clouds' - Deep brick-red flowers almost thornless.
114. *Eucomis* - Green leaves, purplish edges, mauve flowers.
115. *Eucomis* - Green leaves, purplish edges, white flowers.
116. *Eucomis* - Purplish leaves.
117. *Hesperaloe parviflora* 'Ambiance' - Orangish-pink blend.
118. *Hesperaloe parviflora* 'Mellow Yellow'
119. *Hesperaloe parviflora* 'Pink Passion'
120. *Hesperaloe parviflora* 'Pink Sensation' - Large flower.
121. *Hesperaloe parviflora* 'Yellow Passion'
122. *Hesperaloe parviflora* 'Yellow Splendour'
123. *Hesperaloe parviflora* 'Yellow Fever'
124. *Hibiscus mutabilis* x *althaea* 'Marvelous' - Red/red eye.
125. *Hibiscus mutabilis* x *althaea* 'Enchantment' - White/red eye.
126. *Magnolia grandiflora* 'Grande' - Huge leaves.
127. *Morus alba* 'Shangri La' - Zig Zag branches, ruffled textured leaves, from *Morusunryu* seedling, nice sport.
128. *Nerium oleander* 'Illusion' - Yellow flowers.
129. *Prunus mume* 'Amour' - Pink rose.
130. *Prunus mume* 'Elegance' - White/yellow.
131. *Prunus mume* 'Obsession' - Shell pink double.
132. *Prunus mume* 'Pink Passion' - Single pink/white center.
133. *Prunus mume* 'Pink Sensation' - Single pink.

134. *Prunus mume* 'Red Splendour' - Red double.
135. *Prunus mume* 'Sensational' - Pinkish rose.
136. *Prunus mume* 'Snowflurry' - White double.
137. *Prunus mume* 'White Clouds' - Pink & white/greenish yellow eye.
138. *Prunus mume* 'Snowdrift' - White single.
139. *Punica granatum* 'Ebony' - Black fruit.
140. *Punica granatum* 'Elf'
141. *Punica granatum* 'Gnome'
142. *Punica granatum* 'Mardi Gas' - Large orangish-red blossoms.
143. *Punica granatum* 'Midget'
144. *Quercus kelloggii* 'California Sunset' - Stunning red and orange foliage in fall.
145. *Quercus palustris* 'Festival' - Red, orange, yellow fall color.
146. *Quercus palustris* 'Halloween' - Deep orange fall color
147. *Quercus palustris* 'Red Clouds' - Dark red fall color.
148. *Rhodea japonica* - Miniature.
149. *Rhodea japonica* - Variegated edge leaf.
150. *Sequoia sempervirens* 'Kelly's Prostrata' - Green leaves.
151. *Sesbania tripetii* 'Orange Splendour' - Spectacular pumpkin-orange flower.
152. *Sesbania tripetii* 'Sensational' - Beautiful deep reddish orange.
153. *Sprekeastrum* 'Red Bird'
154. *Ulmus parvifolia sempervirens* - Variegated sport.
155. *Ulmus alata* 'Corky'
156. *Ulmus* 'Hokkaido' - Congested sport.
157. *Ulmus* 'Hokkaido' - Large leaved sport.
158. *Ulmus* 'Hokkaido' - Tiny leaved sport.
159. *Vitex agnus-castus* chaste tree 'Pink-sensation' - Pink spires.
160. *Vitex agnus-castus* chaste tree 'Sensational' - Bluish-purple, large, to 24" or more, spires.
161. *Vitex agnus-castus* chaste tree 'Snowdrift' - White spires.
162. *Wisteria sinensis* 'Purple Scentsation'

#### FEATURED HORTICULTURAL REVIEWS IN NEWSPAPERS:

- \* The Fresno Bee, Fresno, California, October 30, 1982 by Guy Keeler.
- \* The Fresno Bee, Fresno, California, October 8, 1988 by Guy Keller.
- \* The New York Times, New York, August 22, 1991 by Linda Yang.
- \* Associated Press, distributed the New York Times article by Linda Yang throughout the U.S.A.

- \* The Stockton Record, Stockton, California, August 23, 1991.
- \* The Chapel Hill Newspaper, Chapel Hill, North Carolina, August 30, 1991.
- \* The San Francisco Chronicle, San Francisco, California, September 4, 1991.
- \* The Argus Newspaper, Fremont, California, September 6, 1991.
- \* The Daily Review, Hayward, California, September 6, 1991.
- \* The Courier News, Elgin, Illinois, 1991 by Lindsay Bond Totten.

**AMERICAN PLANT LIFE SOCIETY AND IBS SERVICE:**

1. 1978-1983. American Plant Life Society, created index of Plant Life and *Herbertia* for Dr. Hamilton Traub, Editor.
2. 1983-1984. Chairman of *Crinum* Committee, American Plant Life Society.
3. 1991. Acting Awards and Recognition Director, IBS; presented Herbert Medal to Dr. Kenneth Mann.
4. 1999-Present. Director of Awards Committee, IBS; Herbert Medal and Hamilton P. Traub Award.
5. 1999. Member of IBS Conservation Committee under Dr. Jim Shields.
6. 2002. Chairman, IBS Symposium at Huntington Library, Art Collections and Botanical Gardens.
7. 2003-Present. Director of Seed and Bulb Exchange (SX/BX), IBS.

### THE HAMILTON P. TRAUB AWARD FOR DISTINGUISHED SERVICE

This award was established in 2000 by the IBS Board of Directors to recognize meritorious service to the Society. It is named after Dr. Hamilton P. Traub, founder of the American Plant Life Society, antecedent of IBS, and editor of its journal for a half century.



#### PAST RECIPIENTS

- 2000 Mr. Charles E. Hardman
- 2001 Mr. Marvin C. Ellenbacker
- 2002 Mr. Michael G. Vassar
- 2003 Dr. Alan W. Meerow
- 2004 Dr. David J. Lehmillier



**2005 TRAUB AWARD**  
**DR. CHARLES GORENSTEIN**



**DR. CHARLES GORENSTEIN**  
**AUTOBIOGRAPHY**

I am a son of holocaust survivors. Soon after end of the Second World War, my parents left Rumania and moved to France where I was born. My father, who excelled in athletics, became a professional soccer player and played for teams in Marseille and Lyon. After a few years, he was traded to a Colombian team. In Colombia I lived in Manizales and Medellin. It was an idyllic country until the political and drug violence became threatening. We packed our bags and left the tropics to live in Canada. After graduating college in Montreal, I moved to the United States where I received a PhD in Biochemistry. I currently live in southern California where I enjoy my family, gardening and hiking in the desert.

It is not everyday that one runs into a bulb, so my first encounter with one is still a memory I can pleasantly recall. I was a little boy collecting butterflies in an abandoned lot, not too far from my home, when a splash of color next to a pile of bricks from a fallen wall caught my attention. A solitary pretty pink flower

stood out like a gem among the rubble and weeds. I carefully dug it out thinking it would make a perfect gift for my 3<sup>rd</sup> grade teacher and was delighted when I noticed it was attached to a walnut-sized bulb.

I carefully potted the little flowering bulb and proudly gave it to my teacher. She thanked me and placed the pot at the back of the classroom, next to my desk where, after a few weeks of neglect, it succumbed in the darkness of the classroom. I was eight years old then, and it was the first in a very long list of bulbs that I have managed to kill.

Thirty years later, while landscaping the backyard of my newly built home, I planted some gladiolus corms and tuberous begonias purchased at the local hardware store. The yard needed some color, and bulbs were cheap so I gave them a try. Within a few days the bulbs rotted. Disappointed and to try to understand why the bulbs perished, I purchased a book on bulbs. Well, it was an epiphany. All those pictures of irresistible beautiful flowers - I was smitten. I had to grow them all!

Disappointment soon followed. Few of the bulbs in my book could be obtained at the local nurseries. After much searching, I managed to obtain a few choice morsels such as *Tecophilaea* and *Romulea* from a British mail order nursery, but in general, the choices were meager. I wanted to grow *Brunsvigia*, *Pamianthe*, *Ixia*, *Paramongaia* .... A trip to the local library finally led me to the American Plant Life Society, which I immediately joined.

An ad in the Society's newsletter asking for a volunteer to run the seed exchange left me apoplectic. Here, I thought, was my chance to be at the epicenter of the bulb world. Here was finally the opportunity to obtain those rare jewels that haunted me from my bulb book. On hearing that my application to become the Director of the Seed Exchange had been accepted, I felt what Willie Horton, the infamous bank robber, would have felt if he had been selected to run the US mint. Bliss!

Soon after becoming Director of the Seed Exchange, I was invited to join the Board of Directors of the IBS. The board meetings at that time were held, *al fresco*, at the UCI Arboretum in Irvine, California, an idyllic setting in which to hold meetings. Dealing with the mechanics of running a plant society was a daunting task, and yet I looked forward to the monthly meetings. The board members were a dedicated and hard working group whose love of bulbous plants was infectious and inspiring.

Running the seed exchange was an exhausting task but not without some benefits, principally access to literally the seeds of thousands of bulb species (For the gory details, visit the IBS web site and read my article on how to run a seed

exchange). I suppose it was madness, but the lure of growing all those species became irresistible. Each year I took a few seeds from the left over accessions and planted them in small pots. Over the years I planted perhaps 4 or 5 thousand accessions. Given the miniscule size of my backyard, I somehow managed to cram thousands of little pots in a space no bigger than a two car garage. To my eyes it was a wonder of the world. My wife would shake her head, tell me the whole thing was madness, and in resignation, I would concur.

In the late nineties, I saw the opportunities which the Internet could provide to the IBS. The IBS Board of Directors agreed that a web site could provide a much needed public exposure and advance the aims of the Society. I tackled the task of web site design with the same zeal I gave the seed exchange. Soon the IBS Web Site had hundreds of bulb images, articles, book reviews, germination protocols and many other useful features. I am happy to note that the IBS Web Page, the little child I spawned, continues to grow and thrive under new stewardship.

As I look back on my tenure as a Board Member of the IBS, I recall with great affection the other board members I had the privilege of serving with and knowing: Charles Hardman, Harold Koopowitz, Elisabeth Lassanyi, Fred Meyers and Michael Vassar. I learned much from them.

## PROPAGATION TECHNIQUES

Floris Barnhoorn

Hadeco

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### METHODS OF PROPAGATING *HIPPEASTRUM* EMPLOYED BY HADECO

Hadeco uses four methods of propagation:

#### **METHOD 1. Through natural off-set or daughter bulb formation.**

Cultivars produce off-sets by varying degrees. Some bulbs are prolific, but others produce only a few bulblets, and some none at all. Hadeco re-plants off-sets, but this is rarely the primary method of multiplication for a cultivar.

#### **METHOD 2. Through basal cutting, as is done with hyacinths.**

After bulbs have been lifted at the end of their growing cycle, cuts are made through the basal plate using a knife. The depth of the cuts is about 10 to 12 mm. The cuts are then dusted with a fungicide. Then the bulbs are stored in a warm, dark place with adequate ventilation and a high humidity until the correct planting season commences. This storage method will pose problems for most home gardeners. One way to achieve it is to bury the bulb in a tray of coarse river-sand, then store in a cupboard where the temperature is constantly around 26°C. The sand may be slightly dampened from time to time. Tiny bulblets will form in the cuts. Plant the mother bulbs right-way-up at the start of the correct planting season. The bulblets will sprout, then grow. This method produces 12 to 15 small daughter bulblets from one mother bulb in one season of growth. The strength of the bulblets is ensured with basal cutting, and the conditions required for development are less sterile than other cutting methods. However, Hadeco rarely uses basal cutting, due to the low yield.

#### **METHOD 3. Twin-scaling.**

Under this method, Hadeco reliably produces between 40 and 60 bulblets from each bulb cut. This process is cheaper than watering, and requires less sterile conditions. It is nonetheless labour-intensive, and Hadeco employs 80 people under supervision and guidance of two managers for 3 to 4 months each year to operate the program. This method in its original form was



developed by Luyten (1926, 1935). The aim is to produce segments of bulb that consist of two scales joined at the base, with sufficient scale tissue to feed the growing bulblet for 3 months. Bulbs entering the program are cleaned of foliage, outer skin and roots. As much basal tissue as possible must be left in place. The bulbs are then dipped in a cocktail of fungicides. Bulbs are initially cut into quarters, and then those quarters are again split into two or three parts, depending on the size of the bulb. This produces 8 to 12 pieces, from which twin scales can be removed by sliding a scalpel between two scales and through the base. It is essential that the twin-scale possesses basal tissue.

These twin-scales are then dipped in the cocktail of fungicides. They are then stored between two 2 cm layers of medium-sized vermiculite in flat trays. Two litres of water for every 100 litres is added to the mixture. Storage temperature is at 28°C and 80% humidity.

After three weeks, an additional 1 litre of water is added to each tray. Three months later, the bulbs have developed bulblets from between the scales, roots from the base, and some foliage. They are then ready for planting out.

#### **METHOD 4. Meristem watering.**

To give an initial boost to bulk up an exciting new hybrid, bulbs are watered under completely sterile conditions. For micropogation, the ideal *Hippeastrum* bulbs should have the spathe just emerging from the bulb. Hadeco ensure the bulbs used are free of any visible diseases, virus and bacteria. The bulbs are cleaned by removing outside scales and roots. Thereafter each bulb is cut into quarters, and the floral stem is dissected out. The quarters are then cut into narrower wedges making sure that the basal plate remains intact. These wedges as well as the floral stems are then disinfected before being transferred to laminar airflows benches in a clean air environment.

The floral stems, being the spathe with its immature flowers inside and the scape, are then cut into discs of about 1 mm in thickness and individually placed flat onto a starting medium in test tubes. These test tubes are put into growing rooms in continuous darkness and 25°C. Bulblet regeneration takes about 90 days but varies considerably between different hybrids. The bulblets are then sub-cultured onto growing medium. They are later transferred to soil. Alternatively, they can be split longitudinally, leaves and roots removed and the bulblet ex-plant then re-inoculated and placed onto fresh medium to produce new bulblets from the base of the mini-scales. Sub-cul-

turing is in darkness for the first 4-6 weeks and a constant temperature of 25°C., after which they are placed under lights for 18 hours per day. The resulting bulblets are sub-cultured again onto growing medium for either transferal to soil or further sub-culturing. It is theoretically possible to sub-culture bulblets indefinitely, but this is not always practical as abnormalities can be generated in the resulting bulbs. The multiplication rate is also cultivar dependant. It is possible though, in three months, to dissect 100 bulbs into a final yield of 25,000 bulblets ready for the greenhouse.

Meristem culture of *Hippeastrum* at Hadeco is also undertaken to try and produce virus free plants. The meristems are removed from the floral discs at a very early stage, long before bulblets have started to form. The meristems are removed with the help of a dissecting microscope and sub-cultured. The efficiency of regeneration of bulblets in *Hippeastrum* hybrids is dependant on quite a number of limiting factors such as: cultivar, floral stem length, position of the explant in the stem, thickness and orientation of the explant, light versus darkness, temperature and medium ingredients such as sugar, mineral nutrition, auxins and cytokinins.

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THE ELUSIVE *HYMENOCALLIS EUCHARIDIFOLIA* BAKER  
(AMARYLLIDACEAE)

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## INTRODUCTION

The beautiful *Hymenocallis eucharidifolia* Baker (1884) was hidden in a shroud of mystery for almost 150 years following its original discovery circa 1870. When he described this bulb, Baker had no knowledge of the collection locality or even the name of the actual collector. Consequently, *H. eucharidifolia* remained virtually unknown and was rarely seen following Baker's account. Many plant explorers searched in vain for decades for this elusive treasure but to no avail. On rare occasions, a bulb would surface mixed in with other *Hymenocallis*, but always the origin remained unknown. Only one known photograph of this bulb was ever published in all these years.

*Hymenocallis eucharidifolia* is not like most other *Hymenocallis*. Its light-green, occasionally glaucous or glaucescent, distinctive-rosette foliage is unmistakable in appearance and resembles that of *Eucharis amazonica* Linden ex Planchon (1857), the Amazon Lily, or of *Hosta*. The purpose of this paper is to review the botanical history, taxonomy and horticulture of the elusive *H. eucharidifolia* from its original discovery in circa 1870 to its recent rediscovery. Shown here for the first time in history is a cross section of *H. eucharidifolia* bulbs from the collection locality in Mexico, including some of the phenomenal variations in its blossoms and foliage. Because of the many locations that are discussed throughout this work, a detailed map showing all the states of Mexico is provided as a reference (Fig. 1).

## HISTORICAL OVERVIEW, A CHRONOLOGICAL ACCOUNT

### I. J. G. Baker, 1884, in *Gardner's Chronicle*, N. S. 21:700.

The type specimen (Fig. 2) was dated May 24, 1884. It was prepared by Baker, who stated that neither the donor nor the origin of the bulb was known. The following account was extracted verbatim from Baker:



- |                        |                      |
|------------------------|----------------------|
| 1. Baja California     | 17. Hidalgo          |
| 2. Baja California Sur | 18. Colima           |
| 3. Sonora              | 19. Michoacán        |
| 4. Chihuahua           | 20. México           |
| 5. Coahuila            | 21. Distrito Federal |
| 6. Sinaloa             | 22. Tlaxcala         |
| 7. Durango             | 23. Morelos          |
| 8. Nueva León          | 24. Puebla           |
| 9. Zacatecas           | 25. Guerrero         |
| 10. Tamaulipas         | 26. Veracruz         |
| 11. Nayarit            | 27. Tabasco          |
| 12. Aguascalientes     | 28. Campeche         |
| 13. San Luis Potosí    | 29. Yucatán          |
| 14. Jalisco            | 30. Quintana Roo     |
| 15. Guanajuato         | 31. Oaxaca           |
| 16. Querétaro          | 32. Chiapas          |

Fig. 1. Mexico States Map





Fig. 2. Type specimen: *Hymenocallis eucharidifolia*. J.G. Baker s.n., May 24, 1884. (Courtesy of K).

**HYMENOCALLIS EUCHARIDIFOLIA, n. sp.\***

This is a new *Hymenocallis* belonging to the group with a long tube and Eucharis-like leaf, allied to *speciosa* and *guianensis*. It is distinguished from its neighbours by its few-flowered umbels, sessile leaves, and large corona. It has flowered for the first time at Kew this summer. It was received in 1882 from an unknown correspondent without any information as to its native country. All the species of the genus come from Tropical or Subtropical America, whilst *Pancratium*, which differs from *Hymenocallis* in seed only, belongs almost exclusively to the Old World.

Bulb ovoid, with thin brown outer tunics. Leaves four, thin, a bright green, cotemporary with the flowers, oblong, 1 foot long, 3-3 1/2 inches broad at the middle, with about fifteen distinct veins between the margin and midrib, branching off from the latter as in a *Eucharis*; blade nearly sessile, with a midrib 1/2 inch broad at the base. Scape ancipitous, 1 foot long. Umbel of 4-5 sessile flowers. Spathe-valves withered by the time the flowers are fully expanded. Ovary oblong-trigonous, under 1/2 inch long. Perianth with a slender green tube 4 inches long; segments linear, deeply channeled down the face, 3-3 1/2 inches long. Corona white, regularly funnel-shaped, 1 1/4 inch long. 1 inch across at the throat, with two distinct cusps on the edge between each filament, free portion of each filament 1-1 1/4 inch long; anthers linear, 1/2 inch long. Style green, exerted beyond the anthers. No distinct scent. **J. G. Baker.**

**2. Thomas Baines, 1884, Paxton's Flower Garden by Professor Lindley and Sir Joseph Paxton, Revised, 3: 158.**

The description for *Hymenocallis eucharidifolia* from Gardner's Chronicle was repeated in its entirety in the article. The following additional commentary was extracted verbatim:

**HYMENOCALLIS EUCHARIDIFOLIA. Baker.** The description given by Mr. Baker conveys an idea that this is a distinct looking species, but not equal in appearance to others of the family, amongst which may be enumerated some of the most beautiful flowering stove bulbs we possess. It will doubtless thrive under like conditions to other allied species, that is, with plenty of heat, light, and moisture during the growing season, with a lower temperature and drier state of the soil when at rest, but never subjected to too low a temperature even in the winter.



Fig. 3. *Choretis glauca*, Plate t. 99, 1838, Knowles and Westcott.

**3. J. G. Baker, 1888, Handbook of the Amaryllideae, p. 122.**

Baker listed *Hymenocallis eucharidifolia* in his famous Handbook, summarizing his original description, and giving Tropical America as its origin without a precise country identified. The following account was extracted verbatim:

4. *H. EUCHARIDIFOLIA* Baker in Gard. Chron. 1884, i. 700. Bulb ovoid, 2-3 in. diam. Leaves 4, oblong, acute, shortly petioled, a foot long, 3-4 in. broad at the middle; midrib distinct; veins lax. Peduncle green, acutely angled, under a foot long. Flowers 4-5 in an umbel, subsessile; outer spathe-valves small, lanceolate. Perianth-tube slender, 4-4½ in. long; segments linear, 3-3½ in. long. Staminal cup narrowly funnel-shaped, 1 ¼ in. long, with 1-2 minute cups between the free tips of the filaments, which are not longer than the cup; anthers linear, ½ in. long. Style overtopping the anthers.

Hab. Tropical America. Described from a plant that flowered at Kew, May 1884. Exact country not known.

**4. J. Robert Sealy, 1954, Kew Bulletin, No. 2:214-215.**

In his Review of the Genus *Hymenocallis*, Sealy described and discussed *Hymenocallis eucharidifolia*, and he made a lengthy detailed comparison to *Choretis galvestonensis* Herbert. The following was extracted verbatim:

(7) *H. eucharidifolia* Baker in Gard. Chron. N. Ser. 21. 700 (1884); et Handb. Amaryll. 122 (1888).

Leaves 4 and sessile *fide* Baker, broad oblong-elliptic, shortly acuminate, cuneate at base, 26-30 cm. long, 7.5 (*fide* Baker) -9 cm. wide, the single leaf seen has the blade passing into a short 4 cm. long petiole-like base which is perhaps part of the sheath, thin bright green, veins clearly visible and well-separated. Scape about 30 cm. high; flowers 4-5, sessile. Perigone: tube about 10 cm. long; segments 6.5-7.5 cm. (-8.7 cm. *fide* Baker) long. Staminal cup funnel-form, 2.7-2.8-(3) cm. high, about 2.5 cm. wide, margins erect with two minute teeth close together midway between one filament and the next; filaments 2.5-3 cm. long. Ovary with 2 ovules in each cell.



**Fig. 4.** *Choretis glauca*, Plate t. 32. 1841, Webb.



CULT. In Hort. Bot. Reg. Kew. 24 May 1884.

Described originally from a plant, of unknown origin, which flowered at Kew in May 1884, and known to me from the type-material only, namely a single leaf and a scape with 1 flower and 3 ovaries. Apart from the absence of a petiole, the leaf strongly resembles some leaves of *H. tubiflora*, and, as in that species, the perigone-segments are markedly shorter than the tube. Both tube and segments are shorter than in *H. tubiflora*, as are the filaments, while the staminal cup is larger and leaves and flowers are fewer. *H. eucharidifolia* differs from *H. speciosa* and *H. fragrans* in the leaves being thinner, as well as epetiolate, by the perigone-tube being longer, the segments much shorter and narrower, and the tube longer, not shorter, than the segments. So far as number, size, and shape of the leaves is concerned, and their being sessile, *H. eucharidifolia* is nearest to *H. choretis*, but this, as will be seen from the description below, has a bigger perigone, and the staminal cup more or less rotate instead of funnel-form.

(8) *H. choretis* Hemsley, Biol. Centr.-Amer. Bot. 3, 335 (1884) Syn. *Choretis glauca* Herbert, Amaryll. 200, t. 35, fig 1, t. 41, fig. 32, 33, t. 44, fig. 45 (1887); Kunth, Enum. Pl. 5, 681 (1850).

*Hymenocallis glauca* (Herb.) Baker ex Benth. & Hook. f., Gen. Pl. 3, 734 (1883) *non H. glauca* (Zucc.) Roem.

Leaves 3 or 4, erect, epetiolate, broad elliptic or elliptic-lorate, obtuse, 30-45 cm. long, 6.2-(7.2-8) cm. wide, glaucous (or glaucescent). Scape (30)-35 cm. high; Spathes erect, narrow (scarcely 4)-5 cm. long; flowers (2)-3 or 4, sessile. Perigone: tube (14)-15 cm. long or more; segments (7-7.5)-9 cm. long, 6-7 mm. wide (outer 7 mm., inner 11 mm. wide). Staminal cup rotate from a short tubulose base, (2.7)-3 cm. long; filaments 2.5-2.8 (3.3-3.5) cm. long. Ovary with 2, sometimes 3, ovules in each cell.

MEXICO: Acaponeta, Tepic Terr., Rose 1502 [?]; Campo Morado, Langlasse 1060 [?].

CULT.: in Hort. Paris. 9 June 1860 (ex herb. J. Gay).

No material has been seen that agrees exactly with Herbert's description and figures, but the specimen from J. Gay's herbarium, cited above, is not very different, and may well represent Herbert's species. This specimen comprises a leaf and a flower from a plant of unknown origin which flowered in the Jardin des Plantes, Paris, in June 1860, and there is a long and detailed description of it in volume 28 of J. Gay's MSS. at Kew. The description above is based primarily on Herbert's account, the dimensions (etc.) in brackets being added from Gay's specimen where it does not conform with Herbert's account. Herbert's plant apparently originated from Mexico; the two Mexican specimen enumerated above agree in leaf, but unfortunately the flowers are too poor to allow certain identification. Herbert regarded this species and *H. galvestonensis* as constituting a distinct genus, which he named *Choretis*, and which he distinguished from *Hymenocallis* by the larger connective, the seeds intermediate between those of that genus and *Ismene*, and by the scape being round instead of ancipitous. The characters, even if constant, are scarcely of generic value and *Choretis* has long been reduced to *Hymenocallis*.

The figure in Knowles & Westcott, *Floral Cabinet*, 2, 101, t. 71 (1838), which purports to be Herbert's *Choretis glauca* (Fig. 3), differs greatly by its shorter, broader, clearly petiolate leaves and shorter perigone-tube. Much of the text is taken from Herbert's account and the authors noted that their plant differed "in some respects from Mr. Herbert's description...." The explanation of the discrepancies eludes me. Incidentally the plate of *Choretis glauca* in Mrs. Loudon's *Ladies Flower Garden of Ornamental Bulbous Plants*, t. 32 (1841), is an adaptation of Knowles & Westcott's-without acknowledgement (Fig. 4)

Baker, *Handbook of the Amaryllideae*, 123 (1888) referred *H. choretis* to *H. glauca* (Zucc.) Roemer, *Syn. Monogr.* 4. 173 (1847), a species originally described by Zuccarini (in *Abh. Akad. Muench.* 2, 317: 1837) as *Pancratium glaucum*. It agrees fairly well with Herbert's species in vegetative characters, but differs sharply by its much smaller flowers-the perigone-tube only 5 cm. long with the segments subequal to it-though the staminal cup is described as rotate, which conforms with Herbert's plant. It is possible that *H. glauca* (Zucc.) Roem. May be an unusually small-flowered example of *H. choretis*, but further information is needed before the point can be decided.

5. H. P. Traub, 1962, *Plant Life* 18: 55-72.

*Hymenocallis eucharidifolia* was mentioned in Traub's Key to the Subgenera, Alliances and Species of *Hymenocallis*.

6. H. P. Traub, 1963, *The Genera of Amaryllidaceae*, p. 76.

*Hymenocallis eucharidifolia* was mentioned.

7. W. S. Flory, 1976, *Nucleus* 19(3): 204-227.

Flory, in his manuscript on chromosome numbers in *Hymenocallis* species, reported that *H. eucharidifolia* had  $2n = 44$  chromosomes. The source of his specimen for this determination came from a collection in 1954 at Jacala, Hidalgo, Mexico. He prepared a herbarium specimen of this bulb, W. Flory 140A-B (Fig. 5 and 6), and deposited it at the Wake Forest University Herbarium (WFU).



**Fig. 5 (left)** *Hymenocallis eucharidifolia*. **Mexico.** Jacala, Hidalgo, W. Flory 140A, 1954. (Courtesy of Wake Forest University Herbarium). **Fig. 6. (right)** *Hymenocallis eucharidifolia*. **Mexico.** Jacala, Hidalgo, W. Flory, 140B, 1954. (Courtesy of Wake Forest University Herbarium).



**8. T. Howard, 1978, *Plant Life* 34: 60-68.**

Howard, in writing about Mexican *Hymenocallis*, provided the following verbatim account of his reputed experience with *H. eucharidifolia*:

*H. eucharidifolia* is endemic to a small area below Chilpancingo, in the state of Guerrero, near the village of Acahuizotla. Compared to other members of the Mexicana alliance, it has to be considered one of the early season bloomers, and if one wishes to collect it in flower, one must go there no later than mid-June. It is the only member of this alliance having broad, thin, Eucharis-like foliage with bright green leaves. The flowers are sweetly scented, unlike *H. choretis*, which is also found there and flowers a month later. There may be 1 to 6 flowers in the umbel. The ovary is sessile, which easily distinguishes it from *H. woelfleana*. The seeds are 1.4 cm long, sharply angled on 2 or more flat planes, rough textured, and are pale dull green. The straight tepal-tubes can be variable in length, ranging from 7 to 13 cm long in individuals. The tepalsegs are shorter than the tube. Pollen is orange.

*H. eucharidifolia* is quite rare within its limited range, and this partly accounts for its being lost to cultivation for nearly a century. Acahuizotla formerly was just on the old road to Acapulco, but years ago a new road was built that completely bypassed the village. Now one must enter a trail through a gate, in order to get to it. It is easily missed.

(Author's note: In a personal communication, Howard stated that he had since realized the above commentary did not relate to *Hymenocallis eucharidifolia*. "I made the identification with the information I had at the time. The information in my article is erroneous." Again, as many times in past history, the origin of the elusive *Hymenocallis eucharidifolia* remained unknown.)

**9. W. S. Flory, 1978, *Plant Life* 34: 47-59.**

In this excellent article on the distribution of *Hymenocallis*, Flory briefly mentioned *Hymenocallis eucharidifolia* as having 44 chromosomes and occurring in the Mexican states of Hidalgo, Nayarit, and Sinaloa (without any specific sites or specimens mentioned).



**10. J. A. Bauml, 1979, Masters Thesis, Cornell University.**

In his graduate thesis on Mexican *Hymenocallis*, Bauml discussed *Hymenocallis eucharidifolia*. The following accounts were extracted verbatim from various sections of Bauml's thesis where *H. eucharidifolia* was mentioned:

Twenty-two species are treated here. This number includes five of the seven names originally placed by Traub (1962) in the Mexican Alliance: *H. eucharidifolia* Bak. is considered an imperfectly known species, ...

I have grown three different collections of *H. harrisiana* in Ithaca, New York. Two of these collections bloomed in Ithaca; the third has bloomed on several occasions in the garden of T. M. Howard. Howard (1978) has interpreted one of these collections, Bauml, Howard, & Lowe 72-159 as *H. eucharidifolia*. I have found this interpretation to be erroneous based on a comparison of flowering plants of this collection with a photograph of the type specimen of *H. eucharidifolia*. A plant of Bauml & Rawlins 104 from the same area in Guerrero flowered in 1978 and was remarkably similar to 72-159 and equally distinct from *H. eucharidifolia*.

**IMPERFECTLY KNOWN SPECIES**

Six species of *Hymenocallis* are included in this chapter, either because they are insufficiently known for publication or, in the case of *H. eucharidifolia*, because the nativity of the plant is unknown. The five numbered species must be recollected and described from living material; additional botanical exploration may eventually reveal the homeland of *H. eucharidifolia*.

Dried leaves of *H. cordifolia* and *H. sp. #1*, both from the state of Guerrero, exhibit the venation pattern of a *Eucharis* leaf. This pattern is characterized by numerous parallel arching veins connected by a network of fine secondary veins. Leaves of *H. eucharidifolia* (see last chapter) also show this venation pattern, suggesting the possibility of rediscovering this species in Mexico.

*Hymenocallis eucharidifolia* Bak., Gard. Chron. 21:700. 1884; Bak., Handb. Amaryll. 122. 1888; Sealy, Kew Bull. 2:214. 1954; Traub, Pl. Life 18:67. 1962.

Holotype: Hort. Bot. Reg. Kew s.n. (K)

Perennial, deciduous (?), bulbous herbs. Bulbs ovoid, with thin, brown,

outer tunics 5–7.5 cm broad. Leaves 4, nearly sessile, thin, bright green, contemporary with the flowers, oblong to broad oblong elliptic, acute to shortly acuminate, cuneate at the base, with about 15 distinct veins between the margin and the midrib, branching off the latter as in a *Eucharis*, 26–30 cm long, 7.5–10 cm broad. Scape acutely angled ca. 30 cm high. Outer floral bracts withered at anthesis. Flowers 3–5, sessile to subsessile, without a distinct scent; tepal tube slender, green, 10–11.3 cm long; tepals deeply channeled dorsally, 6.5 (fide Sealy)–8.8 cm long; staminal cup white, funnelform, 2.5 cm broad at the apex, 2.7 (fide Sealy)–3.1 cm high; with 1–2 distinct teeth on the margin between each filament; filaments 2.5–3.1 cm long; anthers 1.3 cm long; style green, exerted beyond the anthers; ovules 2 per locule.

Chromosome number:  $2n = 44$  (Flory, 1976) [identification questioned].

Phenology: flowering in late May in cultivation.

Distribution: known only from the type specimen flowered in cultivation from material sent to Kew from an unknown correspondent with no information regarding nativity, but suspected of being native to Mexico.

Specimens examined: CULTIVATED: Kew Gardens, Richmond, Surrey, England, 24 May 1884, collector unknown (K-photo BH!).

(Author's note: In summary, Bauml found problems with the specimens identified as *Hymenocallis eucharidifolia* by both Howard and Flory, and he concluded that this species was only known from the original type material of Baker.)

#### 11. S. Ogden, 1994, *Garden Bulbs for the South*, p. 159.

A bulb of *Hymenocallis eucharidifolia* was discovered by Ogden in 1988, when he was employed as a nursery sales representative in the Lower Rio Grand Valley, Texas. An importer was selling a potted bulb labeled as Peruvian Daffodil, but Ogden correctly recognized its identity (Fig. 7). In a personal conversation, Ogden remarked: "As a garden plant, *Hymenocallis eucharidifolia* is one of the most beautiful of *Hymenocallis*." From Ogden's book, his discussion of *H. eucharidifolia* was extracted verbatim:

The fabulous *Hymenocallis eucharidifolia* is a rare, shade-loving species with rosettes of unusually broad, green, Hosta-like foliage. Although unknown to cultivation since its description in 1884, this remarkable bulb has been recently imported into the lower Rio Grande Valley of Texas. The

slender flowers, held upright in groups of two or three, look very small set against the large leaves. The vigorous bulbs thrive in rich leafy soil and seem as hardy as other Mexican Species. They offset at a steady pace, so they may one day become more common in Gardens.

(Author's note: Again, as in the past, the origin of the elusive *Hymenocallis eucharidifolia* remained unknown.)

12. A. W. Meerow et al, 2002, Ann. Missouri Bot. Gard. 89: 400-413.

In their DNA study of the Tribe Hymenocallideae, Meerow et al included *Hymenocallis eucharidifolia* in their analysis. In a personal communication,

Meerow related that the specimen of *H. eucharidifolia* was provided by a European botanical garden and was identified as such by the garden.



Fig. 7. *Hymenocallis eucharidifolia* (Courtesy of Scott Ogden)

### 13. Additional notes.

There have been other unpublished accounts and/or rumors of collectors finding *H. eucharidifolia*; however, most turned out to be misidentifications based upon wishful thinking; i.e., until its reappearance in circa 1994 and in 2001. After Dr. Hamilton Traub's passing, the author inherited all of Dr. Traub's files. An examination of these files revealed that Dr. Traub had been contacted by



individuals who presumed that they had found the elusive *H. eucharidifolia*; however, Dr. Traub determined that not a single one of these presumptive identifications was correct - and as always, the origin of the elusive *H. eucharidifolia* remained unknown.

#### DISCOVERY AND HORTICULTURE

In 2001, I received *Hymenocallis* bulbs to identify from a plant explorer-collector friend (who wishes to remain anonymous). The collector related that the bulbs originated from a low elevation, high rainfall area in the state of Oaxaca, where they grew as an under-story in the jungle. Part of the collection site was being destroyed by residential construction and cultivation, and the collector requested that the specific locality remain anonymous to help protect it from further degradation and exploitation.

Bulbs were planted in rich, river-bottom, sandy-loam soil. Pots were positioned to receive morning sun and afternoon shade; the pots were watered daily during the growing season and kept dry over winter. Bulbs re-established slowly, placing roots to one foot or more in depth, often with no top growth at all for as long as a year or more.

What a surprise when I saw the first leaves. I said to myself, these are not the leaves of *Hymenocallis*; they are similar to the leaves of *Eucharis amazonica*, the Amazon Lily. A scape eventually appeared and grew to about 12 inches in height, and when it began to unfold its blossoms, I could not believe what my eyes beheld. It was the blossom of a *Hymenocallis*! Oh my, it couldn't be, or could it ... the long lost and elusive *Hymenocallis eucharidifolia* had finally surfaced. I immediately ran to the telephone to report the astonishing news to my friend. I said to him: "Do you know what you have discovered?" He replied: "No, what?" I said: "The very rare and sought after



Fig. 8. Various sizes of *Hymenocallis eucharidifolia* bulbs.



*Hymenocallis eucharidifolia*. The whereabouts of this beautiful *Hymenocallis* has been unknown for approximately 150 years. It is one of the rarest and most sought after *Hymenocallis* in existence." He was elated to say the least. There was no question in my mind: its flowers and leaves keyed out to be the elusive *Hymenocallis eucharidifolia* - finally, after all of these years.

Flowers were long lasting, up to five days in hot sunny conditions, with neither flowers nor leaves showing damage when prevailing temperatures reached as high as 114F. The largest bulbs from Mexico measured 12.70-15.24 cm in diameter, and in general, the larger the bulb, the higher the flower count per umbel. I have counted up to 15 flowers on an umbel from one of the largest bulbs. I recorded the following measurements on several exquisite blooming bulbs below:

**(Figure 37):**

Scape - 66.04 cm tall  
 Staminal Cup - 6.35 cm diameter  
 Floral Segment - 10.16 cm long by 1.27 cm wide  
 Perianth Tube - 17.78 cm long  
 Filaments - 3.5 cm long

**(Figure 20):**

Bulb - 12.7 cm diameter  
 Number of Leaves - 13  
 Maximum Leaf Width - 13.97 cm  
 Plant Height - 71.12 cm

Many investigators have implied that the type described is typical of all bulbs of that species. The bulbs of *Hymenocallis eucharidifolia* exhibited in the following images depict a cross section of the colony found in Mexico, and there are many variations to be seen in the foliage and flowering umbels. The images are grouped together to illustrate these variations as well as general features: bulbs (Fig. 8), leaf variations (Fig. 9-22), fruit and seed (Fig. 23-25), flowers, buds, and segments (Fig. 26-38).



**Fig. 9. (Left)** *Hymenocallis eucharidifolia* leaf variation



**Fig. 10. (Below)** *Hymenocallis eucharidifolia* leaf variation

**Fig. 11.** *Hymenocallis eucharidifolia* leaf variation.



**Fig. 12.** *Hymenocallis eucharidifolia* leaf variation.



**Fig. 13.** *Hymenocallis eucharidifolia* leaf variation.





Fig. 14. *Hymenocallis eucharidifolia* leaf variation.



Fig. 15. *Hymenocallis eucharidifolia* leaf variation.



**Fig. 16.** *Hymenocallis eucharidifolia* leaf variation.



**Fig. 17.** *Hymenocallis eucharidifolia* leaf variation.



Fig. 18. *Hymenocallis eucharidifolia* leaf variation.



Fig. 19. *Hymenocallis eucharidifolia* leaf variation.



Fig. 20. *Hymenocallis eucharidifolia* leaf variation.

Fig. 21. *Hymenocallis eucharidifolia* leaf variation.



Fig. 21. *Hymenocallis eucharidifolia* leaf variation.



**Fig. 23. (Above)** *Hymenocallis eucharidifolia* fruit.



**Fig. 24. (Left)** *Hymenocallis eucharidifolia* fruit nearing maturity.





**Fig. 25. (Above)**  
*Hymenocallis eucharidifolia*  
fruit with exposed seeds.

**Fig. 26. (Right)**  
*Hymenocallis eucharidifolia*  
flower buds (12).





Fig. 27. *Hymenocallis eucharisifolia* blossoms, recurving tepal segments.



Fig. 28. *Hymenocallis eucharisifolia* blossoms, upward tepal segments.



Fig. 29. *Hymenocallis eucharidifolia* blossoms, upward tepal segments.



Fig. 30. *Hymenocallis eucharidifolia* blossoms, large spreading tepal segments.





Fig. 31. *Hymenocallis eucharidifolia* blossoms, narrow spreading tepal segments.



Fig. 32. *Hymenocallis eucharidifolia* blossoms, wide tepal segments.





**Fig. 33. (Above)**  
*Hymenocallis eucharidifolia*  
blossoms, large flat tepal  
segments.

**Fig. 34. (Right)**  
*Hymenocallis eucharidifolia*  
blossoms, large wide-  
recurving tepal segments.





**Fig. 35. (Left)** *Hymenocallis eucharidifolia* blossoms, tight upright umbel (9 blossoms)

**Fig. 36. (Below)**  
*Hymenocallis eucharidifolia*  
blossoms, wide tepal  
segments





Fig. 37. *Hymenocallis eucharidifolia* blossoms, exquisite wide tepal segments, see description



Fig. 38. *Hymenocallis eucharidifolia* blossoms, tepal segments pointing upward





**Fig. 39. (Top)** *Hymenocallis eucharidifolia* buds and leaves. (Courtesy of Victor Lambou).

**Fig. 40. (Bottom)** *Hymenocallis eucharidifolia* blossoms. (Courtesy of Victor Lambou).

Several bulbs of *Hymenocallis eucharidifolia* were dispatched in 2003 to Victor Lambou of Crawfordville, Florida, who has provided the following commentary and detailed measurements:

The *Hymenocallis eucharidifolia* bulb, which I obtained in 2003, has bloomed the night of June 25, 2005, for the first time. I am most impressed with the plant and bloom (Fig. 39-40). Details on the bloom are:



Number of buds per scape: 5

Perianth tube:

16.3 cm long

0.5 cm wide at mid length

green

Cup:

5.2 cm wide

funnel form shape

prominent projection between filaments

base not adnate to rays

Segments:

10.9 cm long

1.4 cm max width

spreading near horizontally with outer part of the rays recurved

white top and under side

small yellowish-green eye

Free filaments:

3.4 cm long

nearly erect

Anthers: 1.9 cm long

Pollen: golden

Style: upper portions green fading to white in lower portion

Ovary: 1.2 cm x 1.9 cm

Ovules per locule: 4, 4, & 4

Scape:

33.02 cm long

two edged

glaucous

2 scape bracts:

the largest 8.9 cm long with base width of 1.3 cm

triangulate in shape with a long-acuminate apex

Bulb: 8.2 cm in diameter

The plant has 7 beautiful bright shiny leaves, in a rosette, the largest 48.26 cm long, and 15.24 cm wide. If I saw this plant and did not know its

source, (and I had not seen its bloom), I would have guessed it to be a *Hosta* of some kind. Even without the bloom, it is a most attractive plant. I have it in a 30.48 cm wide, 25.4 cm deep nursery pot. This winter I plan to move it to a larger pot. The second *H. eucharidifolia* I obtained in 2003 has a scape that is starting to elongate. Neither bulb has offset. Obviously, I have destroyed the bloom taking measurements; however, I saved the pollen and placed some on emasculated *H. rotata* and *H. harrisiana* blooms.

#### HYBRIDIZATION

*Hymenocallis eucharidifolia* grew remarkably well in Sanger, California since 2001 when I received the first unknown bulbs and was asked to identify them. In the interim, I attempted many hybrid crosses with *H. eucharidifolia* (and results will be forthcoming in years to come). My cross of *Hymenocallis eucharidifolia* (pollen parent) x *Hymenocallis galvestonensis* (seed parent) produced 9 seedlings showing hybrid vigor and unusual growth in both foliage and bulbs. In 10 months, the leaves had become 12.70 cm long and 1.91 cm wide. At 1 1/2-years, I removed seedlings to repot them into a larger container, and there I found 5 bulbs with a round shape measuring up to 3.18 cm in diameter. Another group of 4 smaller bulbs were leek shaped and measured up to 1.91 cm in diameter and almost 7.62 cm in height. Hopefully, these hybrid bulbs will bloom soon and exhibit exceptional features (Fig. 41).

#### AQUATIC CULTURE

I decided to perform an experiment with one of the bulbs that I had obtained. I placed it in a cup of nothing but water. I wanted to determine how much moisture this species could endure. It was slow to begin growth, similar to the remaining bulbs I had received and had planted in pots. At 8 months, the first leaves began to emerge. Since then, I have continuously grown this bulb in a glass bowl for almost 5 years. Recent measurements of this bulb included: bulb 5.7 cm in diameter, 6 leaves to 30.5 cm long by 7.6 cm wide, and a scape 30.5 cm long. No nutrients were added. I continually refilled the water level to just above the basal plate, and I changed out the water about every two weeks throughout the year. The bulb would go into dormancy every winter, break dormancy in the spring, and then it would produce two scapes with 4 or 5 blossoms every year. It would set seed (I hand pollinated the blossoms) which I distributed to the IBS Seed and Bulb Exchange each year. The bulb was maintained in the living room of my

home, and when I worked in my office, I would often bring it with me as a companion while I worked — what a pleasant aroma while working. This year, for the first time, I decided to give it some fertilizer. I used Schultz liquid plant food 10-15-10 plus micronutrients, 6 to 7 droppers full to the quart of water. The bulb exploded with luxurious leaf growth. This species has shown without doubt, that it can withstand extended periods in a wet environment (Fig. 42.).

#### ACKNOWLEDGEMENTS

A very special debt of gratitude to all listed below for their contributions to this article:

1. Dr. James A. Bauml, Los Angeles County Arboretum.
2. Katherine Chambers, Bio/Ag Sciences Librarian, Shields Library, U. C. Davis.
3. Digital Imaging Lab, U. C. Berkeley Library.
4. Professor Herman Eure, Chairman, Department Of Biology, Wake Forest University.
5. Ilan Eyman, Marion Koshland Bio-Science And Natural Resources Library, U. C. Berkeley.
6. R. Craig Fansler, Preservation Librarian, Z. Smith Reynolds Library, Wake Forest University.
7. Catherine M. Ghan.
8. Anna Haigh, Herbarium, Royal Botanic Gardens, Kew.
9. Gary Hammer.
10. Dr. Thaddeus Howard.
11. World Trade Press, for permission to use the Mexico States Map.
12. Pamela J. Kelly.
13. Karl King.
14. Victor Lambou.
15. Dr. Alan W. Meerow.
16. Scott Ogden.
17. Board of Trustees, Royal Botanic Gardens, Kew, for granting permission to use image data in this manuscript.
18. Patrick Shannon, Inter Library Services, U. C. Berkeley Library.
19. Dr. Gerald L. Smith, High Point University, provided digital images of the W. S. Flory specimen of *Hymenocallis eucharidifolia*. Gerald and Dr. Ray O. Flagg are currently co-curating the W. S. Flory Amaryllidaceae

collections, formerly of the Blandy Experimental Farm, University of Virginia and Wake Forest University Herbarium. The final destination of the W.S. Flory Amaryllidaceae collections will be the Missouri Botanical Garden Herbarium, where the Hamilton P. Traub collections reside.

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**Fig. 42.** *Hymenocallis eucharidifolia* growing aquatically (in a glass of water) for almost five years.

## **CYRTANTHUS STENANTHUS IN MPUMALANGA, SOUTH AFRICA**

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*Photography by Connall Oosterbroek*

*Cyrtanthus stenanthus* is one of several bulbs that have been negatively affected by the degradation of grasslands in eastern South Africa. Habitat degradation has been brought about by agriculture, overgrazing, and the increase in rural and peri-urban human populations. These bulbs have also been adversely affected by the invasion of alien plants often associated with grasslands in poor condition.

*Cyrtanthus stenanthus* populations were studied at three localities: the Thaba Sekhukhune in Sekhukhuneland, the grassland near Leandra on the Eastern Highveld, and the rocky outcrops above the escarpment in the Wakkerstroom District near Dirkiesdorp.

The two varieties of *C. stenanthus*, namely *C. stenanthus* var. *stenanthus* and *C. stenanthus* var. *major*, were not separated for the purposes of this study. There was little if any difference between the two varieties in terms of their autecology. It was interesting to notice, however, that the bulbs known as *C. stenanthus* var. *major* were well represented along the least populated parts of the Thaba Sekhukhune escarpment, but they were not found in equivalent habitat in the central and southern summit areas of the adjacent Leolo Mountains.

The only two distinguishing features between the varieties of *C. stenanthus*, namely length of perianth segments and flower colours, were not found to be consistent when the data for this study was collected. Also no other distinguishing factors were found in the autecology of the two plants to justify varietal separation.

### **CYRTANTHUS STENANTHUS POPULATIONS ALONG THE THABA SEKHUKHUNE ESCARPMENT**

Much of the Thaba Sekhukhune escarpment lay at an altitude of 1500–1600 metres. The area to the west was densely settled with rural villages. A few villages were also situated along the escarpment in the extreme north, but there were far fewer villages in the southeast.



**Fig. 1.** The creamy yellow and pinkish red-brown forms of *Cyrtanthus stenanthus* flowering in grassland of a railway-line reserve near Leandra, south-western Mpumalanga. Photograph taken in late November 2005.

The western slopes of the escarpment consisted either of cultivated fields surrounding the villages or short grassland which was usually overgrazed. *Cyrtanthus stenanthus* bulbs were only found in hilly grassland close to the summit of the escarpment, areas subjected to a negligible amount of grazing. The bulbs grew at the edges of grassy swards, around seepage areas, and amongst grass tufts at the sides of boulders. The species was encountered less frequently amongst short grass growing on rocky outcrops situated on the mountain summit.

The strip of habitat occupied by the bulbs was narrow, varying in width from about 300–500 metres. All of the slopes in this short strip of habitat faced to the east, southeast, or south, thereby losing the sun in many cases in the early afternoon. This habitat contrasted markedly with overgrazed, degraded country on the western slopes exposed to the desiccating rays of the afternoon sun.

The peak of the flowering season was the last two weeks of November following the first of the summer rains. Bulbs flowered in both burnt and unburnt areas with a tendency towards the best flowering after winter grass fires. As this species had relatively long stems, it was able to elevate its flowers above the thickest grass cover. The bulbs were most common in the moist parts of the habitat near seepage areas and least common in areas that dried out quickly after rainfall. The soil consisted of peaty loam which was rich in grass derived compost near the seepage areas.

There were signs of the initial stages of habitat degradation, namely overgrazing and siltation of the upper reaches of seasonal streams and seepage areas. It was concluded that this species will begin to disappear from the Thaba Sekhukhune during the coming decades, as there will be increasing numbers of people, expanding villages, and larger numbers of livestock.

#### **CYRTHUS STENANTHUS NEAR LEANDRA**

The grasslands west of Leandra lay in the extreme south-western corner of Mpumalanga, virtually on the border of the heavily industrialised province of Gauteng. *Cyrtanthus stenanthus* used to be widely distributed here, but it had become extinct in most places as a result of agriculture, habitat degradation, coal mining, and the expansion of informal settlements. The only viable population that was found during the course of the study was located in a grassy railway-line reserve. This reserve consisted of short grassland typical of the region before the advent of agriculture, mining, and informal settlements.





**Fig. 2.** The pinkish red-brown form of *Cyrtanthus stenanthus*. Photograph taken in late November 2005 in grassland of a railway-line reserve near Leandra, south-western Mpumalanga.



**Fig. 3.** The grassland railway-line reserve habitat frequented by *Cyrtanthus stenanthus* near Leandra, south-western Mpumalanga.

The habitat lay at an altitude of about 1600 metres. It was subjected to severe frost in the winter from late May until early August, a time when the bulbs were dormant. The soil consisted of heavy black clay with a dense covering of short grass. This type of habitat was easily degraded by livestock such as cattle and sheep. Many similar areas had been transformed by the invasive exotic-kikuyu grass, *Pennisetum clandestinum*.

*Cyrtanthus stenanthus* bulbs were scattered in the grassland, either growing singly or in small groups. The bulbs thrived in this habitat, and there were seedlings and young bulblets of different ages around the adult bulbs. Winter grass fires were rather erratic, and a few years often passed without a fire. Recruitment of new bulbs to the populations usually occurred in the summers following a winter grass fire. The grass cover at the latter times was sufficient to shade seedlings, but it was free of accumulations of dead plant material which minimized the chances for seeds to germinate. Where the grass was sparse, seeds could germinate without winter grass fires first clearing the veld of dead material.

The peak of the flowering season was the second half of November, with seeds ripening from early January. Seeds were either distributed by wind or fell around the parent bulbs.

The surrounding farmland had been heavily grazed by cattle until recently when chicken farming became established. Suitable areas of the adjacent habitat were searched for *C. stenanthus* during the second half of November 2005, but no bulbs were found. Most of the grassland was degraded and only plants compatible with over-grazed veld were found such as *Ledebouria* and *Crinum bulbispermum*.

It will be interesting to see in coming decades if seeds from *C. stenanthus* bulbs in the railway-line reserve are able to spread into the adjacent grassland. However, the future of the railway-line reserve bulbs is not necessarily secure. Cattle are pastured in this reserve when grazing becomes scarce on a nearby farm. The grazing is periodic and not very heavy, but there are already signs that species such as various *Albuca* and *Ledebouria* are becoming more common. These latter bulbs often increase when grassland in the district is well grazed.

#### **CYRTANTHUS STENANTHUS ON THE ESCARPMENT SOUTHEAST OF WAKKER-STROOM IN THE DIRKIESDORP DISTRICT**

Most of the grassland in this area was located at altitudes greater than 1800 metres. This was a sheep and cattle farming area. Many of the common

bulbous and cormous plants were those that had adapted to or benefited from grazing by cattle and sheep.

*Cyrtanthus stenanthus* was irregular and sparse in occurrence on this escarpment. It was found either on rocky outcrops amongst short tufts of grass or sheltered in clumps of grass growing between boulders, niches where the bulbs escaped trampling by livestock. It cohabited with a rich bulbous and caudiciform flora including *Brachystelma remotum* and *Rhodohypoxis baurii*. No bulbs of *C. stenanthus* were sighted during extensive searches near seepage areas and in moist short grassland near the rocky outcrops.

#### THE FUTURE OF *CYRTHANTHUS STENANTHUS* IN MPUMALANGA

*Cyrtanthus stenanthus* is likely to become locally extinct in many parts of Mpumalanga during the coming decades of this century. Its long term survival in many areas seems improbable in the face of increasing urban sprawl, over-grazing, and habitat degradation and destruction. These human induced changes to the environment are also adversely affecting many other bulbous grassland plants in Mpumalanga.

## CYRTANTHUS ERUBESCENS, A BEAUTIFUL PLANTBULB ENDEMIC TO THE NORTH - CENTRAL DRAKENSBERG, SOUTH AFRICA

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### INTRODUCTION

*Cyrtanthus erubescens* was described by Killich (1960). It was also featured in *Flowering Plants of Africa* (Killich, 1965–1966). As virtually nothing was published about the autecology of this bulb and its habitat, it was decided that a study should be conducted on the bulbs in their natural surroundings.

This species is restricted mainly to remote and seasonally moist ravines and gorges of the north-central Drakensberg. The latter area is isolated and inaccessible. Occasional small populations of *C. erubescens* grow along streams in hilly areas immediately below the gorges of the main Drakensberg escarpment, and these are the bulbs studied in this account.

### THE STUDY AREA

Bulbs were studied in three areas at the time when they bore well-formed seeds, in mid autumn shortly before dormancy. The study localities were fully representative of most indigenous habitats occupied by this species. Small populations of bulbs were observed on ledges under overhanging rocks on very steep hill slopes. Bulbs occurred in small groups consisting of 3–6 mature bulbs and a few bulblets. Bulbs were more plentiful beside streams at the bottom of the slopes growing wedged in amongst moss-covered dolerite boulders. Occasional bulbs were encountered on rocky stream banks growing in thick peaty soil amongst low scrub.

The largest number of *C. erubescens* bulbs was found growing in a steep gorge dropping off from the main Drakensberg escarpment. This gorge was characterised by almost vertical slopes and small cliffs, and it had numerous streams entering it from the side. Bulbs were most abundant on ledges of cliffs, growing in deep soil and swards of moss. Bulbs were only encountered in south and southeast-facing locations and were absent from the drier north facing slopes of the gorge. A few bulbs were found amongst large boulders beside the stream in the bottom of the gorge. This latter





Fig. 1. (Top) A pink flowering *Cyrtanthus erubescens*.

Fig. 2. (Bottom) Details of *Cyrtanthus erubescens* flowers.

habitat was frequently subjected to strong flooding throughout the rainy months from October to early April.

The floor of the gorge beside the stream contained patches of level habitat where seeds could lodge and germinate. Groups of young bulbs were often noted in this area, but they usually did not persist as the majority were swept away when the stream regularly burst its banks during the summer rains.

Groups of bulbs were stable on the cliffs and steep slopes, usually consisting of 6-20 large mature bulbs and a variable number of seedlings from 2-15 in number. However, few seed obtained the opportunity to germinate, since once distributed they became buried amongst thick scrubby vegetation or within clumps of moss. Recruitment of new bulbs to the population was a very slow process, entirely as a result of the limited number of niches in the habitat where seeds could germinate.

*Cyrtanthus erubescens* was absent from a great deal of suitable habitat, and its distribution across the gorges of the north central Drakensberg was by no means uniform.

### THE GROWTH CYCLE

*Cyrtanthus erubescens* is an early flowering species. The peak of the flowering season is usually the first three weeks of October. Flowering may begin with the commencement of the main summer rains, but sometimes sufficient rainfall does not commence until the end of October or in early November. Large bulbs have sufficient reserves to flower in the absence of rainfall. In addition, shaded sides of the ravine are water retentive and remain moist for much of the winter as a result of winter mists and melted snow.

Flowering bulbs are widely scattered across the gorge, and only a few mature bulbs within large clumps flower in a given season. This apparently encourages cross pollination, which appears to be strongly emphasised in *C. erubescens*. (Bulbs in cultivation have been found to be sterile when self pollinated).

*Cyrtanthus erubescens* has extremely long flowering stems, frequently up to 60 cm from the neck of the bulb. This allows flowers to be pollinated with ease as they are elevated well above the dense growth of surrounding plants. It also permits seeds to be as widely distributed as possible by gusts



Fig. 3. A pink flowering *Cyrtanthus erubescens*.

of wind which are frequent at seeding time. Seeds ripen in late November and December some 6-8 weeks after the flowers have been pollinated. The most favourable conditions for the distribution of seeds are hot dry days with gusts of wind. Late November and the first half of December are often periods of prolonged rainy and misty weather in the Drakensberg. Under these conditions the ripening of seeds is delayed, during which time they may be subjected to fungal attack. In addition to the limited niches available to new bulbs, this erratic seeding pattern, owing to inclement weather, also limits the number of seed liberated into the environment.

Bulbs enter dormancy in late April and the first two weeks of May. The leaves wither completely in a very short period of about 10 days. At this stage the mass of long roots retract, drawing the neck of the bulb deep into the soil. Bulbs are well insulated under moss and in peaty soil before the arrival of the first snowfall, which can be expected in late May and June.

#### VARIATION IN FLOWER COLOUR

Flowers of *C. erubescens* are usually a pale dusky pink. White flowering bulbs have been described (Pearse, 1980). The latter seem to occur rather irregularly within groups of bulbs found in gorges leading away from the main Drakensberg escarpment, such as the gorge in the study area. The fre-



Fig. 4. A white flowering *Cyrtanthus erubescens*.





Fig. 5. A white flowering *Cyrtanthus erubescens*.

quency of white flowering *C. erubescens* in the distribution area is unknown at present and would merit further study.

#### THE SPECIES IN CULTIVATION

*Cyrtanthus erubescens* grows well in cultivation in areas with cold dry winters and rainy summers. Elsewhere it should be grown under controlled conditions in a greenhouse. Bulbs should be planted in deep soil in large containers. An ideal soil mix for growing these bulbs in Johannesburg has been found to consist of one third river sand, one third acid compost, and one third gritty sandy soil.

Bulbs grow best in light dappled shade similar to that found in their native habitat in the Drakensberg. They should be thoroughly watered about once every 7-10 days in the summer, but they should be kept dry during the winter. Occasional deep watering may be started in the early spring and increased as the flower buds start to push through the soil.

Seed is readily produced in cultivation but apparently only when plants are cross pollinated. Bulbs do not usually flower, however, unless they are given enough moisture and just the right amount of dappled shade.

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Howard Timmins, Cape Town.



Fig. 6. A new scape of *Cyrtanthus erubescens* pushes through the surface of the soil.



Fig. 7. A *Cyrtanthus erubescens* umbel at the beginning of anthesis, about 2 days after the scape had emerged through the surface of the soil.

*CRINUM ABYSSINICUM* HOCHST, EX A. RICH

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**FIELD ACCOUNT**

During my second trip to Tchad in 1993, Darrel Plowes spawned a side-trip arrangement for me to visit the National Herbarium at Addis Ababa University in Ethiopia. It was a brief encounter lasting six days, two of which were consumed with flights into and out of Ethiopia, and one day was lost to bureaucracy because I was traveling on a Tchadian visa. Dr. Sebsebe Demissew of the Science Faculty was very gracious and organized a



**Fig. 1.** *Crinum abyssinicum* in bud, 14 km northeast of Addis Ababa, 21 July 1993. All photographs by the author.





**Fig. 2.** *Crinum abyssinicum* in flower, 14 km northeast of Addis Ababa, 21 July 1993.

three-day field trip for me, providing a University vehicle with driver and a botany student to accompany me. It was a wonderful adventure, and I shall always remember the hospitality shown to me by my Ethiopian friends.

It was mid July, and I was anticipating warm/hot weather similar to Tchad, since Ethiopia actually is located nearer the equator than Tchad. Unfortunately, I was inadequately clothed for the summer climate in the central Ethiopian plateau. It was cloudy and misty with intermittent brief rain showers the entire time, with daytime temperatures of 65-70F which fell to 40-45F at nighttime. The terrain was lush green, and crops such as barley were in active growth. My immediate priority was to purchase a warm waterproof jacket.

The first day we drove northeast toward Debra Birham. It seemed that

virtually every speck of land was under cultivation. (The Ethiopians use an expression: Wherever an Ethiopian can walk, he will plant something.) Trees other than *Eucalyptus* were rarely noticed. In spite of the extensive cultivation (mostly barley), *Crinum abyssanicum* was flourishing in numerous localities, and it was flowering (Fig. 1, 2.). We literally observed thousands of bulbs, and these were dispersed throughout the cultivated landscape. This symbiosis with agricultural activities was only afforded because mechanized farm implements were not in use. The bulbs had burrowed deep into the soil, falling below the reach of the ox drawn plow. After the fields were plowed and planted in the spring, up with the barley seedlings came the leaves and scapes of *C. abyssanicum* when the rainy season commenced. It seemed that the local peoples either enjoyed the bulbs or accepted them via superstitious beliefs, because the bulbs were left undisturbed year after year.

There were two patterns involving the distribution of these bulbs, accounting for previous confusion that there was a second species present, *C. schimperi* Vatke ex Schumann. However, it was apparent that the same species was just growing in two different habitats. Bulbs were noted to be growing on rocky hillsides in sandy clayish loam, and they were also found in valleys and flatlands where the soil was heavy clay. A few locations displayed a continuous transition zone from hillsides to valley flatlands. Those bulbs growing on the hillsides tended to have globular shapes with short underground necks (Fig. 3.), whereas those bulbs occurring in the clayish flatlands were conically shaped with long underground necks (Fig. 4.). This difference may just have been a cultivation artifact accentuated by the ox drawn plow, but the soil was distinctly a different composition in the two localities.

During the second day, we drove west to Holeta and then north to the Mugger Valley. Again there were many sightings of *C. abyssanicum*. When we reached the outskirts of the Mugger Valley, we came to a huge tract of land fenced off and controlled by the Mugger Cement Factory. After negotiating entry into the valley, we soon encountered relatively undisturbed land as we began to descend the steep wall of the valley beyond the cement excavation areas. Trees were still rare, but the terrain was quite rocky. Then we spied a *Crinum* which was not in bloom, but which had a different leaf pattern from *C. abyssanicum*. Several small bulbs were collected; subsequent cultivation in Southeast Texas has shown these bulbs to bear resemblance to *C. broussonetii* (Redoute) Herbert, but the leaves are shorter and more



**Fig. 3. (Left)** Bulb of *Crinum abyssinicum* displaying a short underground neck, rocky hillside, 12 km north of Holeta, 22 July 1993.



**Fig. 4. (Right)** Bulb of *Crinum abyssinicum* displaying a long underground neck, cultivated flatland, 14 km northeast of Addis Ababa, 21 July 1993.

spreading, while the flowers possess a potent pleasant scent, quite unlike *C. broussonetii* which is virtually unscented (Lehmiller, 1997). A proper investigation regarding the identity has not been attempted at this date.

The third day was uneventful. We drove to Crater Lake as we had obtained data on a collection site from a herbarium specimen at the National Herbarium. En route there were multiple sightings of a pink *C. x powellii*, and there was also a second inferior pink hybrid in cultivation whose origin may have been from one of the rare seeds produced by *C. x powellii*. The terrain about Crater Lake was entirely disturbed, and vast expanses were overgrown with huge stands of an alien invader, the prickly pear cactus. No indigenous *Crinum* were observed the entire day.



The literature provides only brief descriptions of *C. abyssinicum*, and listed below is a detailed account of field measurements obtained during my trip:

*Crinum abyssinicum* Hochst. ex A. Rich.

Type specimen: Ethiopia. Between Easchedcap and Schoata, Schimper 1874, 5 July 1842, K.

Syn.: *Crinum schimperi* Vatke ex Schumann.

Description:

Bulb globular to conical, 3.5–6.0 cm in diameter, tapering to an underground neck 9.0–32.0 cm long, covered with a gray-brown papery tunic. Leaves 4–12, usually without a false stem, initially erect and then spreading laterally while inclining, lanceolate to near strap shaped with a depressed midrib and a long tapering tip, containing weak wooly fibers when torn apart, dull green to near glaucous green, 25–78 cm long by 2.5–3.5 cm wide; margins finely serrated. Scapes light green with distal weak to prominent reddish brown pigment, 9–38 cm long. Spathe initially green upon emergence, but then acquiring a reddish brown pigment, with tapering rounded tips, 7.0–10 cm long by 2.0–2.5 cm wide; beginning to wither at anthesis. Umbel 2–6; flowers zygomorphic, sessile, pleasantly scented. Buds initially red to pinkish red, inclining before anthesis, with most of the pinkish red pigment dissipating before anthesis. Ovaries shiny, dark reddish brown. Perianth tube curved at anthesis, reddish brown with sometimes green distally, 10.5–13.0 cm long. Segments lanceolate, white with some reddish pink pigment on the distal-dorsal outer segments, unequal with the outer segments slightly longer and narrower, 8.5–11.0 cm long by 1.6–2.2 cm wide; apiculates more prominent on the outer segments. Filaments 6, clustered, distally curved, white, unequal with those attached to the inner segments longer, 4.5–9.0 cm long. Style slender and filiform, white, 7.0–8.0 cm long; stigma minutely capitate. Anthers linear and white in buds, turning black and curved at maturity; pollen gray. Fruit globular, umbilicated but sometimes with a short rostellum to 1.5 cm long, displaying shiny red to reddish brown pigment at maturity, 3.0–5.0 cm in diameter; seeds usually 1–2 per fruit but occasionally as many as 8 per fruit, angulated if compressed by adjacent seeds, light greenish tan, not shiny, outer surface discolored by decomposing pericarp, up to 4.5 cm in diameter if solitary.



## DISCUSSION AND CULTIVATION

Henry Nehrling composed a brief dialogue detailing his experiences with *Crinum* in Florida in the early Twentieth Century that was reprinted in *The Standard Cyclopedia of Horticulture* (L.H. Bailey, 1950). Regarding *C. abyssinicum*, Nehrling provided only a brief comment: "*C. abyssinicum* has white flowers and is attractive, but it does not grow well in the sandy soils of Florida." Bailey (1950) commented that *C. abyssinicum* was a greenhouse bulb. G. Ulrich (1936), who resided in Missouri, reported that he maintained *C. abyssinicum* in cultivation, but he remarked that it was a "shy seeder" and that the number of his bulbs was dwindling; he cultivated his bulbs outdoors in the summer, but these were moved to his bulb cellar after the first frost and stored in a completely dry state. Therefore, it appeared that there were bulbs of *C. abyssinicum* in circulation in the U.S. in the early Twentieth Century. However, no offerings of *C. abyssinicum* were to be found in the commercial mail-order catalogs of Amaryllid specialists such as Cecil Houdyshel (1943), Wyndham Wayward (1948), and Grace Primo (1950). How long these bulbs persisted in horticultural circles was unknown. Did Luther Burbank cultivate *C. abyssinicum*? No known records existed regarding Luther Burbank's *Crinum* hybrids. In 1978,

Herbert Kelley Jr. (personal communication) dug several clumps of *Crinum* at a residence in Riverside, California, which the elderly property owner had directly purchased from Luther Burbank. Although there was no identification provided with these bulbs other than they were hybrids



Fig. 5. Fruit of *Crinum abyssinicum*, 2 km south of Chacha, 21 July 1993.

developed by Burbank, L.S. Hannibal later acquired several bulbs, pronounced them to be *C. abyssinicum*, and began distributing them in the U.S. horticultural trade. However, these latter bulbs, some of which still remain in circulation, were not *C. abyssinicum*, but the possibility existed that they could have been a hybrid involving *C. abyssinicum*.

My own experience in cultivating *C. abyssinicum* somewhat parallels that of Nehrling. I possess circa 20 mature bulbs that each spring develop healthy splays of leaves, but the bulbs bloom sporadically, usually in July when it is quite hot, and only rarely are seeds produced. Likely the summers are too hot in Southeast Texas when compared to the central Ethiopian plateau. Also, when a bulb does bloom for me, the flowers tend to be somewhat tubular shaped rather than trumpet shaped as found in Ethiopia; flowers also lack much of the red pigmentation, and they have short perianth tubes (Fig. 7). In my opinion, this species has limited horticultural value in my climate, but it may perform well in a cooler northern climate. Surprisingly, the type specimen of *C. abyssinicum*, Schrimper, #1874, K, has similar floral features to my cultivated bulbs, suggesting that it originated from a stunted bulb possibly related to one of the Ethiopian droughts. The latter appearance also may have contributed to the confusion regarding *C. schrimperi*, the latter whose description more closely parallels my field measurements.



Fig. 6. Seed of *Crinum abyssinicum*, 23 July 1993.

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Fig. 7. *Crinum abyssinicum* in cultivation, Southeast Texas.



## ANATOMICAL FEATURES OF THREE SPECIES OF AMARYLLIDACEAE FROM NORTH-EASTERN BRAZIL

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### ABSTRACT

*Griffinia gardneriana* Herb., *Habranthus sylvaticus* Herb., and *Hippeastrum stylosum* Herb. (Amaryllidaceae) from north-eastern Brazil were studied to elucidate the internal structures of the leaves, cataphylls and roots and relate them to the taxonomy of the family. The species were collected in Catimbau National Park, Buíque, Pernambuco and subjected to standard anatomical techniques. Striated epicuticular waxes, 1-layered epidermis and anomocytic stomata on the leaf surfaces, air cavities, cells containing single raphids and mucilage storage, and aquiferous parenchymatic cells in cataphylls are common characters to the studied taxa. Palisade tissue appears only in *Habranthus sylvaticus* and a compact mesophyll in *Griffinia gardneriana*. The vascular bundles in the cataphylls are distributed in a row in *Hippeastrum stylosum* and *Habranthus sylvaticus* and two rows in *Griffinia gardneriana*. The roots of *Hippeastrum stylosum* show a heterogeneous radicular cortex. Leaves, cataphylls and roots have tracheids with annular, helicoid or both thickenings. Vessels with scalariform perforation plates and pits are restricted to roots.

Key-Words: Amaryllidaceae, Anatomy, *caatinga*, Griffineae, Hippeastreae.

### INTRODUCTION

The family Amaryllidaceae has approximately 850 species in 600 genera widely distributed in temperate and tropical regions, with three main dispersion centers: South America, Southern Africa and the European



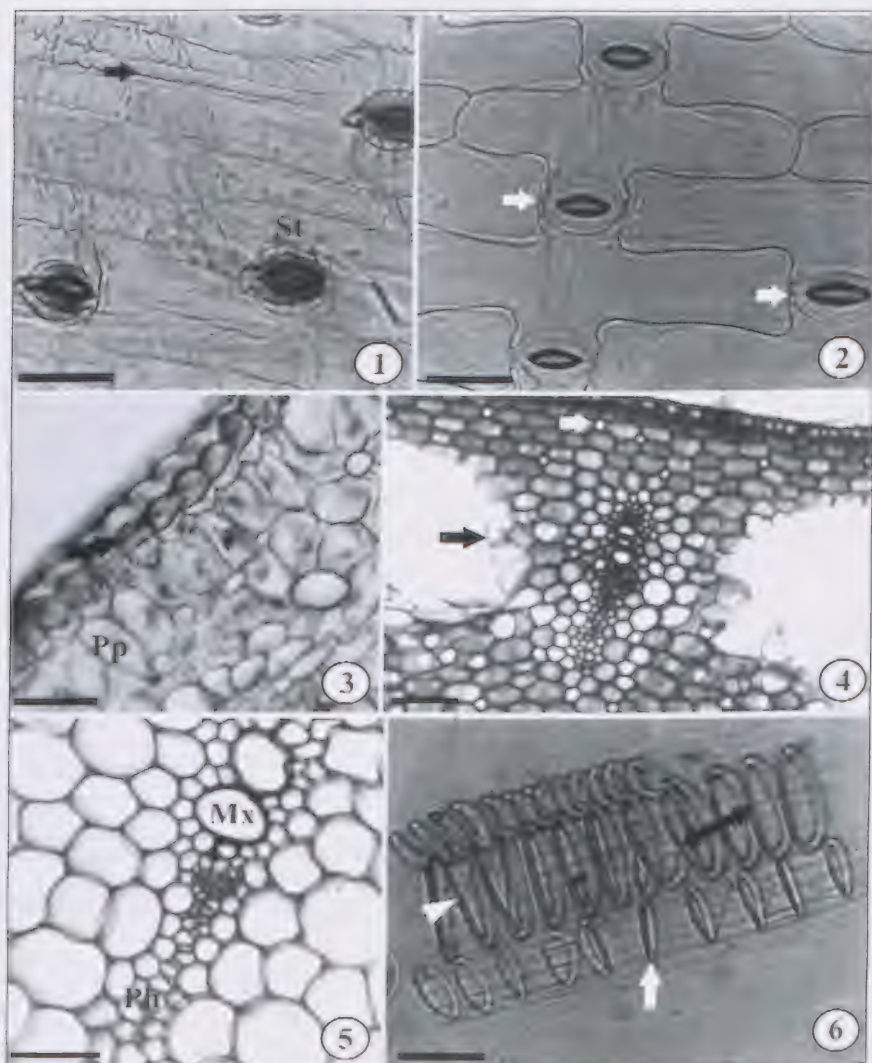
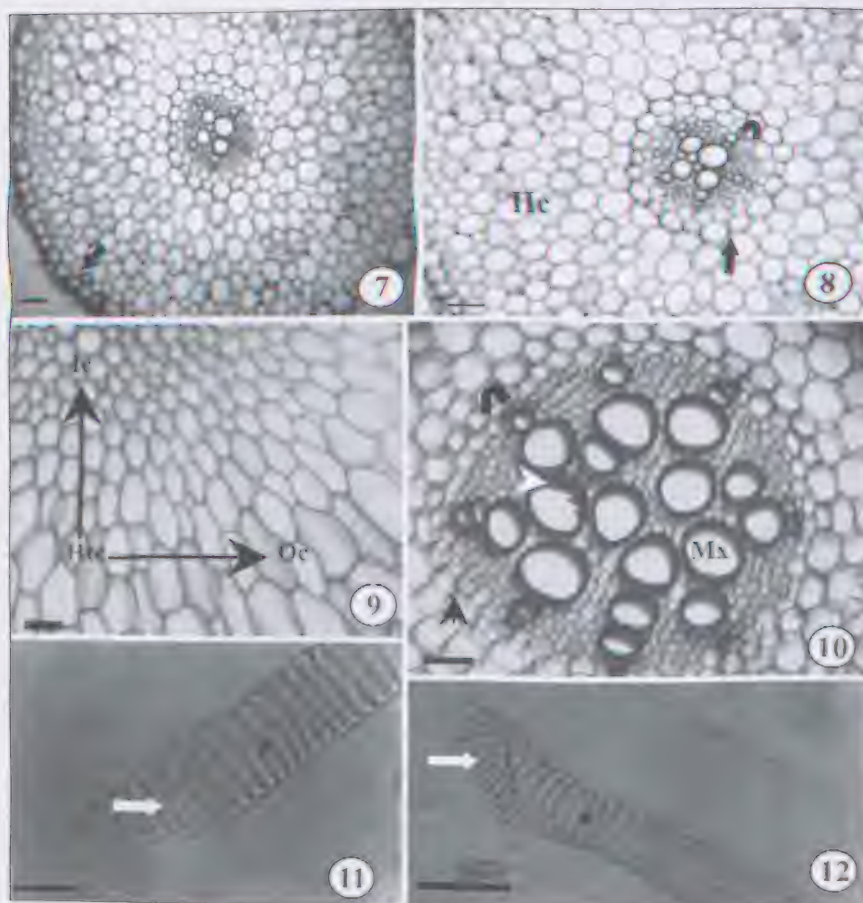


Fig. 1-6. Leaves

1. *Hippeastrum stylosum* (PV), abaxial surface, showing striae (black arrow) on the epicuticular wax.
2. *Griffinia gardneriana* (PV), abaxial surface, showing truncate ends of the epidermical cells (white arrows).
3. *Habranthus sylvaticus* (TS), note the outer periclinal wall thickness of the epidermical cells (wide black arrow) and palisade parenchyma.
4. *Griffinia gardneriana* (TS), general view, showing the air cavities from a lysigenous process – refer to the broken walls of the cells (black arrow), idioblasts with single raphids and mucilage (white arrow), and vascular bundle.
5. *Hippeastrum stylosum* (TS), detail of vascular system.
6. *Griffinia gardneriana* (TS), tracheids with annular (white arrow), helicoidal (white head arrow) and mixed (black double arrow) secondary thickening.

**Legend:** St: Stomata; Pl: Phloem; Ac: Air cavities; Pp: Palisade parenchyma.

**Bars:** Figures 1-3. 60mm; 4. 200mm; 5. 60mm; 6. 80mm.



**Fig. 7-12. Roots**

7. *Habranthus sylvaticus*, general view, black arrow indicating biseriate exodermis.

8. *Habranthus sylvaticus*, homogeneous cortical region, conspicuous Casparian strip (black arrow) and xylem formed by five poles of protoxylem (curved black arrow).

9. *Hippeastrum stylosum*, heterogeneous cortex (black arrows) showing the inner and outer layers.

10. Detail of vascular system of *Griffinia gardneriana*; the black arrow indicates the Casparian strip of the endodermis, which is formed by eight poles of protoxylem (curved black arrow). Note the fragment of scalariform perforation plate (white arrow) in the metaxylem.

11. *Griffinia gardneriana*, vessel elements.

12. *Hippeastrum stylosum*, vessel elements with scalariform perforation plate (white arrow) as well as pits (\*).

**Legend:** Hc: Homogeneous cortex; Htc: Heterogeneous cortex; Ic: Inner cortex;  
Oc: Outer cortex; Mx: Metaxylema.

Bars: Figures 7. 30µm; 8. 20µm; 9. 5µm; 10. 45µm; 11-12. 80µm.

Mediterranean region (Meerow, 2003). Some of the Brazilian Amaryllidaceae are found in different ecosystems, such as the Atlantic Rain Forest and the *caatinga*. In northeastern Brazil, there are approximately 20 species, belonging to the genera *Cearanthes*<sup>1</sup>, *Griffinia*, *Habranthus*, *Hippeastrum*, and *Zephyranthes*, which are distributed throughout the region. The State of Bahia has the greatest species richness (Cowley, 1995; Dutilh, 2003).

Considering the great phenotypic plasticity and the similarity of the leaves and the other organs among species of the family, anatomy becomes an important tool for taxonomic diagnosis. The principal works examining anatomy in the Amaryllidaceae were performed using exotic species from the other countries and regions of the world, such as those by Cheadle (1969), Shah and Gopal (1970) and Arroyo and Cutler (1984). These authors report the internal structure of Amaryllidaceae species belonging to several tribes and genera. Morphological and anatomical studies by Raymunde<sup>2</sup> *et al.* (2000) with *Hymenocallis*, as well as by Arroyo (1982a) increased the knowledge on bulb organization in the family. Recently, Davis and Barnett (1977) studied leaf anatomy in *Galanthus* species, and Šcepánková and Hudák (2004) examined foliar and tepal anatomy in *Galanthus nivalis* L. and *Leucojum aestivum* L. Both of these works are important data sources concerning anatomical features with taxonomic implications.

The aims of this study are first to investigate the anatomical features among the different taxa and secondly to relate these features to their taxonomy.

## MATERIALS AND METHODS

*Griffinia gardneriana* Herb. (A. Alves-Araújo 008, 033), classified in the tribe Griffineae (Meerow, 2003); and *Habranthus sylvaticus* Herb. (A. Alves-Araújo 002, 006, 020) and *Hippeastrum stylosum* Herb. (A. Alves-Araújo 017, 032), both belonging to the tribe Hippeastreae (Meerow and Snijman, 1998), were collected in sandy soil, along the Conchas and Canyon trails in Catimbau National Park, Buíque, in the semi-arid region of Pernambuco State, Brazil. The park covers approximately 62,000 ha, with a geomorphology formed predominantly of arenitic elements (Andrade *et al.*, 2004), temperature and average annual precipitation of 25°C and 1,100 mm respectively (SUDENE, 1990), and a vegetation classified as dense, semi-deciduous shrub formation (Andrade *et al.*, 2004). The specimens were collected at an



altitude of between 960 and 980 m (08°32" S and 37°14" W). *Hippeastrum stylosum* was always found under shrubs, while *Griffinia gardneriana* and *Habranthus sylvaticus* occurred in open areas. The vouchers are in the UFP and UEC herbaria collections.

For the anatomical analysis, the samples were fixed using FAA 50 and conserved in 70% ethanol (Johansen, 1940). Totally expanded leaves, cataphylls and roots from each species were transversely sectioned (TS) by hand with razor blades. The sections were clarified using 50% sodium hypochlorite and submitted to double staining with safrablue (Kraus and Arduin, 1997). Techniques like dissociation with hydrogen peroxide and acetic acid (Franklin, 1945) and diafanization with 50% sodium hypochlorite were performed to observe the tracheal elements and leaf epidermis, respectively. These samples were stained with 50% hydroalcoholic safranine (Kraus and Arduin, 1997).

Microchemistry tests were made using Lugol for starch (Johansen, 1940), ferric chloride for phenolic substances (Johansen, 1940), Sudam III for lipid substances (Sass, 1951), and ruthenium red for mucilage (Kraus and Arduin, 1997).

The nomenclature adopted by Arroyo and Cutler (1984) and Metcalfe and Chalk (1979) for typological classification of epicuticular wax and stomates, respectively, was followed. Photographic records were realized using a Zeiss photomicroscope.

## RESULTS AND DISCUSSION

### 1. Leaf

Under paradermical view (PV), we observed an epicuticular wax layer forming a set of parallel striae on the epidermal cell surface. These structures can also show a perpendicular form, sometimes not visibly covering some epidermal cells, but always present near stomata (Fig. 1). According to Arroyo and Cutler (1984), these ornate forms occur in other Amaryllidaceae species. The organization of these striae on the studied leaves is classified as V-type, because the central striae (primary) are conspicuous while the secondary ones are smaller and arise from them and toward the anticlinal wall. Analyses of the cuticle and epicuticular waxes have taxonomic value for some groups of Amaryllidaceae. Raymundo *et al.* (2000), studying some Venezuelan *Hymenocallis* species, observed that leaf cuticle thickness could be used for taxonomic diagnosis. In the same ways, Weiglin (2001) analyzed different patterns of epicuticular wax deposition of 32 species of *Gethyllis*



and proposed an infrageneric reorganization of groups based on which showed identical patterns, suggesting close, phylogenetic relationships among their members. In contrast, this character, under the parameters used in the present work, did not distinguish among *Griffinia gardneriana*, *Habranthus sylvaticus* and *Hippeastrum stylosum*, as the pattern is uniform in these species.

Dispersed anomocytic stomata (Fig. 2) occur on both leaf surfaces, but mostly on the abaxial surface. In *Hippeastrum stylosum*, the distribution stops at the midrib. Stomata typology and distribution on leaf surfaces are, usually, commonly studied in Amaryllidaceae (Arroyo and Cutler, 1984; Meerow and Snijman, 1998). Additionally, these characters were reported in other anatomical studies with several genera (Asatrian, 1984; Meerow, 1989; Davis and Barnett, 1997). Among the analyzed species, however, the stomata arrangement in respect to epidermal cell level of the leaves can work as a diagnostic character. In *Griffinia gardneriana* and *Habranthus sylvaticus*, the stomata are in the same level of the epidermal cells, while they can occur slightly above them in *Hippeastrum stylosum*.

In PV, rectangular cells are more or less similar in respect to morphology and show straight anticlinal walls forming the epidermis. In *Griffinia gardneriana* those cells are larger and shorter than in the other two species. The ends of the anticlinal walls can be truncated in *Griffinia gardneriana* (Fig. 2) and *Hippeastrum stylosum*, the former species with wider cells, or truncate in *Habranthus sylvaticus*. However, there is a great diversity of epidermal cell forms among the family members. This character is very distinct and consistent in different specimens analyzed for each species. Meerow (1989) adopted this character in his description of *Eucharis* and *Caliphruria*, as was done for the genera *Hymenocallis* (Artyushenko, 1996; Raymunde et al., 2000) and *Galanthus* (Davis and Barnett, 1997). All these authors report a high taxonomic importance of the epidermal cell arrangement for several groups. In transverse section (TS), the epidermis is one-layered with its outer periclinal walls thickened. Its cells are isodiametric and isomorphic, exhibiting small papillae on the outer periclinal walls in the leaf border region of *Hippeastrum stylosum*. On the abaxial leaf surface of *Habranthus sylvaticus*, we observed cells of distinct sizes intercalated between themselves. Subjacent to the epidermis, on the basal third of *Hippeastrum stylosum* leaves, we detected collenchyma occurring in broad regions and, also, below the midrib.

Spongy parenchyma is common to all three species, but *Habranthus syl-*

*vaticus* shows a small layer of palisade cells in both surfaces (Fig. 3). The presence and arrangement of palisade tissue in leaves of *Habranthus* can be used as a taxonomic character for some species groups (Arroyo and Cutler, 1984) and, according to Meerow (1989), the absence of this tissue is an important apomorphic feature for the family. The cellular arrangement of spongy tissue varies; it can be denser and compact in *Griffinia gardneriana* (Fig. 4) or more lax and with bigger intercellular spaces in *Hippeastrum striatum*. This feature can, however, be intermediate in *Habranthus sylvaticus* when compared to the other two species.

Idioblasts containing single raphids and mucilage (Fig. 4) are dispersed among chlorophyllous parenchyma cells and have an aleatory distribution, occurring from near vascular bundles to below the epidermis. These cells are common in the family (Arroyo and Cutler, 1984; Meerow and Snijman, 1998), though they are referred to as sacs (Dahlgren *et al.*, 1985) due their elongated forms and perpendicular position related to other cells. In TS, these structures can be recognized by their small and round lumen.

In contrast to chlorophyllous tissue, the middle region of interfascicular mesophyll tissue has cells that present thin walls and a large lumen. Actually, these morphological characters are evidence for the initial process of lysigenous air cavity genesis (Fig. 4). This character occurs in all of the studied species and corroborates data reported in other Amaryllidaceae (Meerow and Snijman, 1998; Meerow, 2003), and even in several unrelated families like Bromeliaceae (Proença and Sajo, 2004), Cyperaceae (Martins, personal communication), Heliconiaceae (Simão and Scatena, 2004), Iridaceae (Rudall, 1991; 1994), and Zingiberaceae (Albuquerque and Neves, 2004), though its genesis may be different. The aerenchyma tissue becomes more evident between the vascular bundles of the middle region, where its distribution reaches the endodermis and chlorenchyma tissue of both leaf surfaces.

The vascular system looks like an arch and the midrib is slightly larger than other veins in the broadest region of the leaf (Fig. 5). This kind of disposition occurs, usually, in bifacial leaves, and not in unifacial leaves that have a cylindrical form. Nevertheless, intermediate forms do exist and may be evidence for evolutionary relatedness (Arroyo and Cutler, 1984). The parallel collateral bundles have an elongated linear arrangement and are perpendicular to the organ axis, due to the xylem organization and, primarily, the phloem tissue. This arrangement was already reported by Davis and Barnett (1997) for species of *Galanthus*. We observed the same conforma-

tion in *Griffinia gardneriana*, *Habranthus sylvaticus* and *Hippeastrum stylosum*.

The xylem tissue is formed exclusively by parenchymatic cells and tracheids with walls of helicoid, annular or mixed thickenings (Fig. 6), the latter being when both types occur in the same cell. This data corroborate Cheadle's (1969) observation of the presence of vessels as an exclusive character of the roots in Amaryllidaceae. Both metaxylem and protoxylem vary from 1-3 units per vascular bundle. The phloem tissue can have a variable number of cells and is proportionally less elongated the further the tissue is from the midrib.

## 2. Cataphylls

The analyzed bulbs are classified as tunicates and have concentric cataphylls totally surrounding the buds (Bell, 1998), which be axillary (*Habranthus* and *Hippeastrum*) or terminal depending on the genus (Arroyo, 1982a). In PV, the structure of the cataphylls displayed little variation among the taxa, presenting an epidermis formed by rectangular cells with truncated ends on both surfaces, except in *Habranthus sylvaticus*, which had pointed ends.

In TS, cataphylls show a conformation very similar to leaves. The epidermis is one-layered and composed of rectangular cells that have thin walls in *Griffinia gardneriana* or with a slight thickness of the outer periclinal wall of *Habranthus sylvaticus* and *Hippeastrum stylosum*. Below the epidermis, we can find intercalated cells of different sizes and shapes, idioblasts containing several single raphids and storage cells with mucilage. According to Fahn and Cutler (1992), the presence of mucilage is very important in different storage organs, because its properties increase liquid retention. The storage structures are distributed near the adaxial epidermis surface, corroborating the findings of Arroyo and Cutler (1984).

In TS, the cataphyll mesophyll texture distinguishes the species, for example more dense in *Habranthus sylvaticus* or lax in *Griffinia gardneriana* and *Hippeastrum stylosum*.

The mesophyll can be divided into two different regions: one composed of amyiferous parenchyma, and another characterized by the presence of aquiferous parenchyma. The starch storage tissue occurs close to the abaxial surface and reaches the level of the vascular bundles. The uppermost cells, therefore, are 4-7 cells distant from the epidermis. The aquiferous parenchyma is distinguished mainly by the presence of cells with large lumens, thin walls, and a variable disposition among the species near to the adaxial sur-



face of the cataphyll. Mann (1952) observed in cataphylls of *Allium sativum* L. (Alliaceae), the presence of storage tissues with centripetal conformation when compared to species studied in this paper. This observation, however, can be explained by the morphological type of the *Allium sativum* bulb, which is classified as solid (Mann, 1952). In both tunicate and solid bulbs, parenchyma cells tend to collapse, therefore reducing the number of cell layers and, consequently, organ thickness. This feature reflects the age of the cataphylls; the oldest ones are found in the outer region of the bulb, and so act like a physical protective tissue for the meristematic buds (Arroyo, 1982a). The presence of aquiferous parenchyma, absence of air cavities, absence of chlorophyll and stomata are the main distinguishing characters of the cataphylls and leaves in the analyzed species.

The vascular system of the cataphylls is similar to leaves, although it can be arranged in two layers with small bundles: one near the abaxial surface and another one in the middle region of the mesophyll as reported in *Griffinia gardneriana*. In *Habranthus sylvaticus* and *Hippeastrum stylosum*, the bundles are larger and elongated in the direction of both surfaces of the epidermis, and they are distributed in only one layer. In the first case, the anatomical arrangement differs from that reported by Arroyo and Cutler (1984) for some species they studied. In their paper, the authors report an irregular distribution, but this is not corroborated in our observations of *Griffinia gardneriana*.

### 3. Roots

In TS, the roots show a uniseriate and persistent epidermis. The persistence of epidermis distinguishes South American species from the African ones which develop a velamen (Arroyo and Cutler, 1984). Arroyo (1982b) also reports the presence of this character for *Ixiolirion*, a taxon nowadays classified in the family Ixioliriaceae (APG II, 2003). Root hairs are absent in mature roots, and the exodermis is uniseriate, except in *Habranthus sylvaticus* which has biseriate exodermic tissue (Fig. 7) composed of hexagonal cells. The cortical region, formed by several layers of cells with similar shape and size, is homogeneous in *Griffinia gardneriana* and *Habranthus sylvaticus* (Fig. 8) and heterogeneous in *Hippeastrum stylosum* (Fig. 9). The heterogeneity is due to the presence of two different cortical regions: the outer one composed of parenchymatic cells with a large lumen close to the exodermis, and an inner one formed by 5-7 layers of parenchymatic cells that are nearly isodiametric and lack or have scarce intercellular spaces. Both of these



arrangements were also reported by Arroyo and Cutler (1984). A uniseriate endodermis with a conspicuous Casparian strip (Fig. 9) is common to these species.

Xylem and phloem alternate in the root vascular system. Differences can be observed in the number of protoxylem poles from each species. The number can be either five (Fig. 8) or six in *Habranthus sylvaticus*, six in *Hippeastrum stylosum*, and eight in *Griffinia gardneriana* (Fig. 10). Metaxylem occupies the center of the stele and has a variable number of tracheal elements.

In roots, in addition to tracheids with a thickness similar to those observed in leaves and cataphylls, vessel elements also occur. These elements are present exclusively in roots, as reported by Cheadle (1969) who affirmed the presence of these cells only in roots of several species, including members of Agapanthaceae, Alliaceae, Amaryllidaceae and Ixioliriaceae. In Cheadle's treatment (1969), the studied taxa were classified as belonging to the Amaryllidaceae.

The morphological features of vessel elements were treated as an important character and were elucidated by Cheadle (1968; 1969). The vessel elements have scalariform oblique perforation plates and a scalariform pattern of pits (Fig. 10, 11, 12). These structures are difficult to see sometimes due to the disposition of wall thickness. Cheadle (1969) assigned an evolutionary significance to the observed features, attributing them to the tribes Agapantheae and Allieae, nowadays classified as Agapanthaceae and Alliaceae (APG II, 2003), as being intermediate in state. According to the author, the vessel elements of Amaryllidaceae constitute the climax of evolution of tracheal elements in this group. However, this disposition of perforation plates is not restricted to the afore-mentioned families, or even to the order Asparagales, in which they are classified. Cheadle and Hosakai (1971) detected very similar structural shapes in members of Liliaceae *sensu lato*. In fact, Cheadle (1968) also observed them in Haemodorales, an order currently reassigned into Commelinales. These taxa share several similarities with the tracheal elements of some species of Hypoxidaceae and Velloziaceae.

The anatomical features observed in the leaves, cataphylls and roots are sufficient to distinguish the studied taxa. However, many of these features are common to several members of the Amaryllidaceae.

# ACKNOWLEDGEMENTS

This work was made possible by CNPq through financial support awarded to the first author. Thanks are also extended to Dr. Julie Dutilh, for her help with specimen identification, and to the members of the Laboratório de Morfo-Taxonomia Vegetal of the Centro de Ciências Biológicas-UFPE, for their support and help with this paper.

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**ALLIUM FRASERI (ALLIACEAE) AND ITS ALLIES**

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**INTRODUCTION**

At least four species of *Allium* (*A. fraseri*, *A. texanum*, and two newly identified species) from Texas have been lumped under the epithet *Allium canadense* L. var. *fraseri* by Ownbey (1950). An effort has been made to untangle this complicated problem.

**1. *Allium fraseri* (Ownbey) Shinnars emend. T.M. Howard**

Syn. *Allium canadense* L. var. *fraseri* M. Ownbey, pro parte, Research Studies, State College of Washington 18(4):181-222, 1950.

*Allium fraseri* (Ownbey) Shinnars, pro parte, Field and Laboratory 19:104, 1951.

*Allium lavendulare* var. *fraseri* Shinnars, pro parte, Field and Laboratory 20:164, 1953.

*Allium acetabulum* (Raf.) Shinnars, pro parte, Field and Laboratory 25:31-32, 1957.

**EMENDED DESCRIPTION:**

Bulb ovoid, without basal bulblets, ca. 2 cm long, ca. 1 cm wide, often in clusters, inner coats whitish, epidermal cells obscure, vertically elongate, regular or nearly so, outer coats persisting as a series of grayish-brown, fibrous, fine to coarse meshed open reticula, enclosing 1 or more bulbs. Leaves 3-7, suberect, spreading, mid-green at anthesis, shorter than the scape, 3-6 mm broad, channeled or slightly flattened, concave-convex in cross section, margins entire. Scape 20-50 cm long, terete, 1-2 per bulb; spathe membranous, caudate, breaking before anthesis into usually 3, ovate to lanceolate, attenuate, 5-7 nerved bracts, which may remain partially united at the base.

Umbel slightly fragrant, many-flowered (16-80), erect, pedicels becoming subequal in length, mostly 2-3 times that of the perianth, elongating and becoming flexuous and rigid in fruit; perianth broadly campanulate, segments 5-8 mm long, elliptic to lanceolate, acute or obtuse, entire, spreading, cream-white, withering in fruit, the midribs somewhat thickened; stamens shorter than the perianth, filaments subulate, dilated, and united into a cup at the base, anthers yellowish-white, oblong, obtuse; ovary yellowish-white



**Fig. 1.** *Allium fraseri* (Ownbey) Shinneryi emend. T. M. Howard, Bexar County, Texas, April 21, 1990. All photographs by the author.

to greenish, crestless; style linear, about equaling the filaments in length, stigma capitate, entire or obscurely lobed. Seeds black, shining, finely alveolate, alveoli with a minute pustule in center.

Type: Texas. Kerr County, Bear Creek, Heller 1684, April 21, 1894 (WS).  
Lectotype: Texas. Kerr County, Bear Creek, Howard 90-21, April 22, 1990 (MO).

Isotype: Texas. Bexar County, roadside Hwy 281, 2 miles north of Loop 1604, San Antonio, Howard 90-18, April 21, 1990 (MO).

Chromosome count:  $2n = 14$  (Ownbey and Aase, 1955, culture #972).

## DISCUSSION

Ownbey (1950) reduced several distinctive *Allium* taxa (*A. cristatum* Jones, *A. fraseri* (Ownbey) Shinnery, *A. lavendulare* Bates, and *A. mobile* Regel) to varieties of a single species, *A. canadense* L., basing this change on the presence of reticulated bulb coats which they shared in varying degrees. All but *A. lavendulare* were found in Texas. This concept was rejected by Texas field botanists such as Shinnery and Cory, who were both at Southern Methodist University. They considered these four taxa as distinct species. The subsequent name changes for *A. fraseri* were rather surprising, especially when one considered that Shinnery renamed it three times in succession in response to Ownbey's concept that "variety *fraseri*" was a form of *A. canadense*. Shinnery was correct in his defiance, but it was unfortunate that he took such a tortured route to make his point. He could have stopped with *A. fraseri* (Ownbey) Shinnery. Each time he changed his mind, he amplified the confusion. His final epithet was *A. acetabulum* (Raf.) Shinnery, from *Geboscon acetabulum* Rafinesque, which was really a synonym for *Northoscordum bivalve*.

Previous references to the several forms ascribed to *A. fraseri* by Ownbey and Shinnery are referred to as "pro parte" since their original descriptions were compiled from four different white-flowered species ranging from South Dakota to Texas. The above emended description defines *A. fraseri*, while excluding the other three allied taxa (*A. eulae*, *A. pseudofraseri*, and *A. texanum*) which Ownbey had seen fit to include along with the type form (Heller 1684) collected along Bear Creek, Kerr County, Texas, in 1894.

Ownbey named his new variety of *A. canadense* to honor the Right Reverend Monsignor Samuel V. Fraser of Aurora, Kansas, who described *A. perdulce* in 1940, and who discovered the new *Allium* taxon in Kansas which had the white flowers. The varietal name *fraseri* was applied as one of the several floriferous varieties for *A. canadense*.

In correspondence with Rev. Fraser, Cory thought that he too had found this new form with the white flowers in Texas, and they exchanged material. Cory expressed an opinion that Fraser had found an undescribed species.

But Ownbey selected a different *Allium* to represent the type for *A. canadense* var. *fraseri*, based on the Heller 1684 specimen from Kerr County, Texas, not realizing that the latter differed from Fraser's bulb in several important details, easily observed in living material but not easily observed in dried specimens.

Thus the Texas taxon became the type for "var. *fraseri*", while the Kansas





Fig. 2. *Allium pseudofraseri* T. M. Howard in cultivation.



Fig. 3. *Allium eulae* T. M. Howard in cultivation; rare pinkish form.



taxon was excluded through mistaken identity. Rev. Fraser was inadvertently honored by the wrong plant, and no one was the wiser. Shinnery (1951) elevated *A. canadense* var. *fraseri* to specific rank, based on the single collection Fraser 56256, Kansas, Dickinson County, Western Herrington, south east of the entrance to Herrington Cemetery, 1949. This species was found in Oklahoma, East-central Texas and North Texas, and was the species familiar to Shinnery and Cory. Neither of these men realized that the *Allium* species from Kerr County, Texas, was a very different bulb and each inadvertently helped perpetuate the error. They were more concerned with separating *A. canadense* from *A. fraseri* and failed to note the important differences between them. Thus *A. fraseri* was defined as a species apart from *A. canadense* and other related white-flowered Texas species having reticulated bulb coats (and lacking bulbils in the umbel).

Each species breaks down into its own geographical forms, which in turn have their own varieties. In defining *A. fraseri* based upon the type material, there is a species endemic to the Edwards Plateau and Hill Country of Texas, growing among scattered live oak trees in well drained black alkaline soil. The flowers are slightly fragrant in many-flowered hemispherical umbels.

## 2. *Allium pseudofraseri* T.M. Howard, species novo.

Syn. *Allium fraseri* (Ownbey) Shinnery, pro parte, Field and Laboratory 19:104, 1951.

*Allium canadense* L. var. *fraseri* Ownbey, pro parte, Research Studies, State College of Washington 18(4):181-222, 1950.

Affinis a *A. eulae* at *A. fraseri* sed differt en florens urceolatus, praecox vernus, pedicellis gracilis, suaveolens hyacinthoides; habitatio arenosum, non alkalinus. Differt *A. canadense* en umbellatibus bulbillis deficientibus, habitatio minus uvidus, bulbo plus densus tunicato; a *A. fraseri* en flores praecox vernus urceolatus; plus suaveolens hyacinthoides, foliis late spiralis, a *A. texanum* en planta parvus, foliis angustius, viridis, florens praecox, bulbo plus densus tunicato, ovoideo, antheris subroseus; a *A. eulae* en florens praecox, plus suaveolens, bulbo plus densus tunicato, ovoideo, foliis primum crescens hiemalis.

## DESCRIPTION:

Bulb ovoid, without basal bulblets, one of a cluster, ca. 1.5 cm long, ca. 1.0

cm wide, inner coats whitish, epidermal cells obscure, vertically elongate, regular or nearly so, outer coats persisting in layers of grayish fibrous, fine to coarsely meshed open reticulate, enclosing one or more bulbs. Leaves 3-7 per bulb, green at anthesis, channeled, concave-convex in cross section, 3-10 mm wide, margins entire, usually shorter than or equal to the scape, erect to suberect in lower half, broadly spiraling. Scapes 1-2 per bulb, 15-35 cm long, terete; spathe membranaceous, caudate, splitting before anthesis into usually three, ovate to lanceolate, attenuate, 6-7 nerved bracts, which remain partially united at the base. Umbel many-flowered (20-100+), densely hemispherical, flowers with a sweet hyacinth-like fragrance in the afternoon; pedicels slender, erect, becoming subequal in length, mostly 3-4 times that of the perianth, elongating and becoming flexuous to rigid in fruit; perianth urceolate to sub-campanulate, segments 5-7 mm long, elliptic to lanceolate, obtuse or acute at apex, suberect, milky-white to pinkish, or (rarely) pink, withering in fruit, persistent, the mid-ribs somewhat thickened; stamens usually shorter than the perianth, filaments subulate, dilated and united into a cup at the base; anthers pink, pinkish, or cream-white, oblong, obtuse; ovary greenish, crestless; style linear, about equaling the filaments in length, stigma capitate, entirely or obscurely lobed. Seeds black, shining, finely alveolate, alveoli of each with a minute central pustule.

Type: Texas. Tarrant County, Bluebird Avenue, Oakhurst, Fort Worth, V. L. Cory 54345, April 16, 1948 (WS).

Chromosome count:  $2n = 14$  (Ownbey and Aase, 1955, culture #612.)

3. *Allium eulae* (V.L. Cory) T.M. Howard, species novo.

Syn. *Allium canadense* L. var. *fraseri* Ownbey, pro parte, Research Studies, State College of Washington, 18(4):181-222, 1950.

*Allium fraseri* var. *eulae* V.L. Cory, unpublished, personal communication, with copy of notes entitled Notes on *Allium*, V.L. Cory.

*Allium fraseri* (Ownbey) Shinnars affinis sed differt bulbo sub-globosus, tunicato extra albedo, plerumque deficienti fibris reticulatibus, anguste linearifoliis, suberectis, spiralibus, hebitis viridis, emergens praecox autumnalis, florens inodori, tepali proximus cochlear-formis, ovario albidus.

**DESCRIPTION:**

Bulb sub-globose to globose, ca. 1.5 cm long, ca. 1.8 cm wide, single or one of a cluster, epidermal cells obscure, vertically elongate, regular or nearly so, outer coats when present a series of grayish-tan, striate with elongate cells in regular vertical rows, inner coats membranous, whitish, with or without vestigial fibrous reticulations, not always persisting. Leaves 4-6, erect to suberect, somewhat spiraled, bright green, somewhat flattened or channeled, concave-convex in cross section, 3-5 mm wide, margins entire or minutely denticulate, shorter or equal to the scape. Scape 1-2 per bulb, 40-50 cm long, terete; spathe membranaceous, caudate, breaking before anthesis usually into 3, ovate to lanceolate, attenuate, 3-7 nerved bracts which may remain partially united at base. Umbel many flowered (20-90), scentless or faintly alliaceous, erect; pedicels becoming subequal in length, most 3-4 times that of the perianth, elongating and becoming flexuous and rigid in fruit; perianth stellate to broadly campanulate, segments 5-6 mm long, 2-3 mm wide, elliptic-lanceolate to sub-cochleate, acute or obtuse, entire, spreading, cream-white, rarely pinkish, withering in fruit, the midribs somewhat thickened; stamens usually shorter than the perianth, filaments subulate, dilated into a cup at base; anthers whitish to pinkish, oblong, obtuse; ovary whitish, rarely pinkish, crestless; style linear, about equaling the filaments in length, stigma capitate, entire or obtusely lobed. Seeds black, shining, finely alveolate, alveoli each with a minute pustule at center.

Type: **Texas.** Burnet County, Granite Mountain, Marble Falls, V.L. Cory 49515, June 4, 1949 (WS).

Chromosome count:  $2n = 14$  (Ownbey and Aase, 1955, culture #314).

Habitat: Endemic to granite hills of Central Texas in Burnet, Gillespie, and Llano Counties, in wet, seepy places and swales in full sun. Late April-May.

**DISCUSSION**

Allied to *A. fraseri* (Ownbey) Shinnars and *A. texanum* T.M. Howard, but differs from *A. fraseri* in greater height, with erect to suberect, spiraled, dull green foliage emerging in early autumn. The bulbs are spherical and lack the heavy reticulations. Like *A. texanum*, the smaller flowers are scentless or nearly so, with nearly spoon-shaped, acute segments, and whitish ovaries. It differs from *A. texanum* in having darker, narrower linear foliage, smaller bulbs, and is of a less robust habit. The flower segments are of a different shape, and the ovary is whitish rather than greenish.



## KEY

1. Bulbs ovoid with heavy gray or tan reticulations. Leaves narrowly linear.
  - A. Flowers fragrant with scent of hyacinths, segments urceolate, white (rarely pink), with ovary yellowish or pinkish. Leaves erect, usually growing in sandy soil, in eastern half of Texas.....*A. pseudofraseri*.
  - B. Flowers faintly fragrant, campanulate, white. Leaves suberect, mid-green, growing in well drained, black alkaline soil of Edwards Plateau.....*A. fraseri*.
2. Bulbs globose or ovoid, tunics lacking or faintly reticulated. Flowers scentless, or with alliaceous odor.
  - A. Flowers stellate to broadly campanulate, white, rarely pink, scentless or faintly alliaceous. Stamens and ovary white. Leaves suberect to erect, narrowly linear, dull green. Seepy places on granite hills of Central Texas.....*A. eulae*.
  - B. Bulbs robust, many-flowered. Flowers broadly campanulate, scentless. Leaves erect, spiraled, 5-10 mm wide, glaucous. River bottoms and seepy places in Central Texas and Oklahoma.....*A. texanum*.

## CONCLUSION

Ownbey lumped *A. fraseri*, *A. eulae*, *A. pseudofraseri*, and *A. texanum* as forms of *A. canadense* var. *fraseri*, but his concept was awkward and did not take fully into account how they differ from one another, each with its own set of distinctive characters, such as tunics and bulb forms, presence or absence of fragrances, foliage characters, each occupying its own ecological niche, differing flower times, etc. The only thing they have in common is that each is white flowered in many-flowered umbels. Foliage of each is distinct from one another as is the season of foliar emergence, whether it is late summer, winter, or early spring. A loose set of standards must be employed for one to consider them all variant races of *A. fraseri* and that each is merely a variety of *A. canadense*. This top-heavy concept stretches credibility, proving that the *A. canadense* Alliance is sorely in need of revision.

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TAXONOMIC REVISION OF THE  
GENUS *RHINOPETALUM* (LILIACEAE) IN IRAN

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ABSTRACT

Taxonomic revision of the genus *Rhinopetalum* in Iran is presented, including a key, synonyms, descriptions, illustrations, taxonomic comments, ecology, and citation of specimens examined. The genus *Rhinopetalum* contains five species, *Rh. gibbosum* (Boiss.) Losinsk. & Vved., *Rh. arianum* Losinsk. & Vved., *Rh. karelinii* Fisch. ex D. Don, *Rh. bucharicum* (Regel) Losinsk., and *Rh. stenanthum* Regel, of which the two former ones occur in Iran. It is concluded that the following characters are very important in taxonomy of the genus: bulb morphology; stem and habit; leaf number, shape, colour and position; inflorescence, flower colour and morphology; nectary, androecium and pollen morphology; gynoecium, fruit and seed morphology.

**Key words:** *Rhinopetalum*, taxonomy, morphology, ecology.

1. INTRODUCTION

The genus *Rhinopetalum* was suggested by Fischer but he did not publish the name, which was first done by Alexander in Edinburgh New Phil. Journal (1830). Later, Baker (1874) treated it as a subgenus of *Fritillaria*. Boissier (1882) did not accord any infra-generic status to this group of species and simply included it in his subsect. *Olostyleae* of *Fritillaria*. *Rhinopetalum* was revived as a separate genus by Losina-Losinkaya (1935) in the Flora of the U.R.S.S., who distinguished it from *Fritillaria* mainly on nectary characters. She recognized five species in the genus, namely *Rh. karelinii* Fisch., *Rh. gibbosum* (Boiss.) Los.-Losinsk. & Vved., *Rh. arianum* Los.-Losinsk. & Vved., *Rh. stenanthum* Regel (Fig. 3), and *Rh. bucharicum* (Regel) Los.-Losinsk., of which *Rh. arianum* and *Rh. gibbosum* occur in Iran. Because of the characteristic structure of the nectaries in *Rhinopetalum* as revealed by the scanning electron microscope (SEM), and also its general divergence from other fritillaries, segregation of subgenus *Rhinopetalum* from *Fritillaria* into a distinct genus was supported again by Bakhshi Khaniki & Persson (1997).

The aim of the present investigation has been to produce a modern morphologic and taxonomic revision of *Rhinopetalum* in Iran, using as much data as possible with the aid of light microscopy (LM) and scanning electron microscopy (SEM).

## 2. MATERIAL AND METHODS

This revision was based on wild material. In addition to material collected by the author from the field, material from the following herbaria was also examined (abbreviations according to Holmgren et al. (1990): BG, E, G, GB, JE, K, TARI, TUH, and W. Fifteen specimens were also studied in the field in Iran (the collected living material is cultivated at the Göteborg Botanical Garden, Sweden), and another three were seen live in cultivation. Voucher specimens were kept in GB. The material was studied and measured under a stereo microscope. Nectaries, stamens, styles and seeds of all species were also studied in the scanning electron microscope. For this purpose, samples taken from fresh material and fixed and stored in FAA were critical-point dried and coated with a 50 Å layer of gold-palladium. The following informative characters were judged for morphologic and taxonomic studies: 1) bulb morphology, 2) stem and habit, 3) leaf number, shape, colour and position, 4) inflorescence, 5) flower colour and morphology, 6) nectary morphology, 7) androecium, 8) pollen morphology, 9) gynoecium morphology, 10) fruit morphology, 11) seed morphology. Descriptions and notes on habitats and altitudes refer to Iranian material.

## 3. RESULTS AND DISCUSSION

### 3.1. Character Descriptions

**3.1a. Bulbs.** Bulb characters are invaluable for generic and sometimes for specific differentiation. In the genus *Rhinopetalum* the bulb usually consists of 2, sometimes 3 or 4, fleshy, subglobose scales  $\pm$  tunicated by the marcescent remains of the scales of previous years.

**3.1b. Stems and habit.** Flowering stems are erect and terete, with 1/3 of the stem usually subterranean, mostly unridged and glabrous, sometimes densely papillose. The stems vary considerably in height and robustness, even in the same population and in the same plant from year to year. The stems are frequently, especially in the lower supraterranean part, suffused with deep anthocyanin purple. In some species they are markedly glaucous.

- 3.1c. **Leaves.** Very young bulbs have, in all species so far examined, a single green leaf which is generally different in size and shape from the cauline leaves of the adult flowering stem of the species. Usually it is broader, elliptic or lanceolate to ovate and narrowing below into a long or short petiole. General leaf-shape is rather constant, but there is often considerable variation in size. The arrangement (alternate, opposite, whorled) of the cauline leaves on the stem is of considerable taxonomic importance. Leaves usually occur from a little below the middle of the stem ( $\pm$  at ground level) up to the first flower, or in single-flowered stems they cease at some distance below the perianth. Presence of many bract leaves, surrounding and overtopping the flowers, is diagnostically important. Leaf colour (glaucous or green) is also of diagnostic value. Most species have glaucous leaves, while they are shiny green in others.
- 3.1d. **Inflorescence.** The genus *Rhinopetalum* has up to 11 flowers in a terminal raceme, with two bracts subtending each flower.
- 3.1e. **Flowers.** The general shape of the perianth is most important taxonomically. The outline of the flowers depends on the relative length and breadth of the tepals, the degree of differentiation of the outer and inner tepals, the spread of the tepals and the size, shape and depth of the nectaries.

The flowers of some species of *Rhinopetalum* are regular and actinomorphic with the formula normal for the *Liliaceae*. They are often drooping, usually hanging quite or nearly parallel to the stem. The pendulous position is said to protect the nectaries from being washed out by rain. Generally, the flowers of *Rhinopetalum* are narrowly campanulate. Many of the species have a slight to fairly strong odour. The flowers are obviously adapted to insect pollination. More information about pollination is given in Bakhshi Khaniki & Persson (1997). The flower in some species of *Rhinopetalum* (*Rh. arianum*, *Rh. gibbosum*) is irregular and zygomorphic due to unequal nectary-projections in different perianth segments.

The colouring of the flowers raises many taxonomic problems. Within one and the same taxonomic species there is frequently considerable variation. This involves the shade or kind of colour, the depth of colour, the pattern of colouring, the intensity of tessellation, and the presence or absence of a median stripe (*fascia*). Tessellation on the perianth is characteristic of *Rhinopetalum*, although it is lacking in some species.



- 3.1f. Nectaries.** Both inner and outer tepals have nectaries on the inside towards the base, or at least well below the middle of the tepal. The long narrow-furrowed nectaries of some fritillaries occur also in *Lilium*, but the ovate to almost circular pit of some *Fritillaria* species is apparently restricted to this genus within *Liliaceae* s. str. More information in detail about nectary morphology and its taxonomic implications in *Fritillaria* and *Rhinopetalum* is given in Bakhshi Khaniki & Persson (1997).
- 3.1g. Androecium.** The surface structure of the filament (papillose or glabrous) is taxonomically important and useful for subgeneric classification. All *Rhinopetalum* species have  $\pm$  papillose filaments. Shape, size and colour of filaments seem taxonomically unimportant, however.
- 3.1h. Pollen.** Detailed palynomorphological studies on large numbers of *Rhinopetalum* species had never been performed before. The pollen morphology of some species was studied by SEM. All were characterized by having monocolpate pollen, but the pattern of exine surface and sculpture showed some differences. The pollen grains of the species within the genus *Rhinopetalum* had a rugulate surface.
- 3.1i. Gynoeceum.** The ovary is three-carpellate and three-locular. Taxonomists have laid considerable stress on the branching and structure of the style. On the whole, this organ seems to give very valuable characters. Not only does style-branching give us useful subgeneric and sectional (*Trichostyleae* and *Olostyleae*) characters, but otherwise closely related species can frequently be most definitely separated by the shape of the style, or other styler characters. However, in some cases, it would be worth considering whether there are not some species with a trifid style more closely related to species with a lobulate or undivided style than to those with which they have been associated. Styles in the genus *Rhinopetalum* are undivided. The pubescence of styles is also useful for subgeneric characterization and formal grouping. Among *Rhinopetalum* species, the styles are papillose in *Rh. stenanthum*, but glabrous in the rest of the species.
- 3.1j. Fruit and seed.** The fruit in *Fritillaria* and *Rhinopetalum* is a three-valved loculicidal capsule, that is longitudinal dehiscence occurs down the centre of the outer walls of the three compartments or loculi. The general shape of the capsule and the acute or obtuse, rounded or even slightly winged angles of the mature fruit are of taxonomic importance. Among *Rhinopetalum* species both winged and wingless capsules



Fig. 1. a. *Rhinopetalum arianum*.

Fig. 1. b. *Rhinopetalum gibbosum*.

can be found. The seeds are numerous in each capsule, and disc-shaped with a flat rim. Generally, the outline of the seeds is elliptic to ovate. There are some differences in shape and size of testa cells among different species, but these differences do not seem to be very important taxonomically.

### 3.2. *Rhinopetalum* Fisch. ex Alexand.

Fischer ex J.E. Alexander, Edinb. New Phil. J. 8:19. 1830.

*Fritillaria* subgen. *Rhinopetalum* (Fisch. ex Alexand.) Baker, J. Linn. Soc. 14:253, 1874.

Type species: *Rh. karelinii* Fischer ex D. Don in Sweet, Brit. Flow. Gard. 6 (Ser. 2,3): t. 283, 1835. Type LE (n.v.). (See illustration in Fig. 2)

#### General description of Iranian species:

Bulbous perennials; bulb usually of 2, sometimes 3 or 4 fleshy or farinaceous subglobose scales,  $\pm$  tunicated by the marcescent remains of scales of the previous year or years. Stem erect, smooth or papillose. Leaves usually glaucous, opposite to alternate, linear, lanceolate to ovate. Flowers nodding or  $\pm$  horizontal at maturity, 1-7 or more in racemes. Perianth zygomorphic or actinomorphic, cup-shaped or bell-shaped. Nectaries deeply depressed, appearing on the outside of the tepals as dark hump or sac-like projections, equal in some species, unequal in others, nectary orifice bordered by two  $\pm$  fringed, purplish-brown lobes, which are densely short-ciliate at least basally in. Filaments  $\pm$  papillose. Anthers basifixed. Pollen monocolpate, often rugulate. Style glabrous, entire, slender. Ovary 6-angled. Fruit a  $\pm$  depressed-globose capsule, winged or wingless, narrowed into a stipe. Seeds numerous, discoid, ovate in outline, with a wide flat margin.



Fig. 2. *Rhinopetalum karelinii*. a) a flowering plant, b) part of stem with base of bracts and pedicel, c) uppermost outer tepal, d) lateral outer tepal, e) inner tepal, f) stamen and gynoecium, g) part of fruiting stem, h) seed.

### 3.3. Key to the Iranian taxa of *Rhinopetalum*.

- Perianth segments distinctly pink-tessellated; nectary lobes broad; filaments very minutely papillose at base.....1. *Rh. gibbosum*  
Perianth segments finely pink-spotted; nectary lobes very narrow; filaments densely papillose at base.....2. *Rh. arianum*

#### 3.3a. *Rhinopetalum gibbosum* (Boiss.) Los.-Losinsk. & Vved. (Fig. 1a)

Losina-Losinskaya & Vvedensky, in Komarov, Fl. U.R.S.S. 4:297, 1935.

*Fritillaria gibbosa* Boissier, Diagn. Pl. Nov. 1 (7):107, 1846.

*Fritillaria karelinii* Fisch. f. *gibbosa* (Boiss.) Bornmüller, Pl. Strauss., Beih. Bot. Centralbl. 24:99, 1908.

Type: Iran. "Schiraz, in declivibus prope ruinas Persepolis", April 1842, Kotschy 827 (holo. G-Boiss., iso. P!).



Fig. 3. *Rhinopetalum stenanthum*.



*F. pterocarpa* Stocks, Hooker's J. Bot. 4:180, 1852 (n.v.).

lc.: Furse & Nowell, The Lily Year Book 27, Fig. 42, 1964. – Mathew, J. Roy. Hort. Soc. 99: Fig. 11, 1965. – Wendelbo, Tulips & Irises of Iran, Fig. 26, 1977. – Rechinger, Flora Iranica 165, t. 173, Fig. 4, 1990.

#### Description:

Bulb narrowly ovoid to subglobose, up to 3 cm diameter, consisting of two fleshy scales; without bulbils or stolons. Stem 7-17-(25) cm, densely papillose, especially at base. Leaves 4-10-(12), usually opposite, glaucous; the lowest 3.5-7 x 1-2 cm, lanceolate to ovate; the upper shorter and much narrower than the lower, linear, acute; bract leaves linear, acute, usually 2 at the base of each pedicel. Flowers 1-7-(10), nodding at maturity, zygomorphic. Perianth segments 15-20 x 7-10 mm,  $\pm$  pink-tessellated, with many dark nerves, darker at the base, ovate-lanceolate; the outer somewhat narrower than the inner. Nectaries placed ca. 0.5 mm above the base of the perianth segments, ca. 3-5.5 mm at orifice, the upper larger than the others, strongly calcarate, bordered by two broad, fringed, purplish-brown lobes, which are densely short-ciliate basally; nectaries of the outer tepals much more deeply impressed than those of the inner series. Filaments (5)-8-10 mm long, usually purplish, slender, minutely papillose toward base. Anthers 2-2.5 mm long, broadly oblong, purplish; pollen sculpture rugulate. Style 6-13 mm long, slender, entire, glabrous, pale purplish. Ovary 5-6 mm long, cylindrical, 6-angled. Capsule 10-16 mm long, subglobose, winged, toothed at top. Seeds 4.5-6 x 2-3 mm, ovate in outline.

Chromosome number:  $2n = 24$  (Bakhshi Khaniki, 1998).

Flowering time: Early March-May.

Ecology and distribution: Stony slopes, steppes, bare rocky soil, rounded clay hills, 625-2050 m. Also known from Turkomania, Afghanistan, Pakistan and S. Transcaucasia.

*Rhinopetalum gibbosum* is a rather widespread species in Iran. It is rather variable both in number and colour of the flowers. It resembles *Rh. arianum* in the shape of the perianth segments and in general shape of the nectaries, but differs in having a chequered pattern on its perianth, wide nectary lobes (Bakhshi Khaniki & Persson 1997), and only minutely papillose filaments.

## Specimens Examined:

**Iran:** *Tehran:* road from Tehran to Karaj, Park-e Chitgar, 1350 m, 23.3.1993, Bakhshi Khaniki 1 (GB); Lashkarak towards Afgeh, Kuhhay-e Nārun, 1550–1750 m, 30.4.1976, Termeh & Matin 34905 (W, E), 1550 m, 29.3.1993, Bakhshi Khaniki 2 (GB); Mardabad, south of Karaj, frequent on hills, 1200 m, 30.3.1976, Wendelbo et al. 19047 (GB, TARI), 1350 m, 3.4.1993, Bakhshi Khaniki 3 (GB); Karaj, Ravandeh, 5.4.1934, Maula 8022 (GB, E), Gauba et al. 1565 (W); ridge north-west of Qum lake on road from Tehran, stony slopes, 1350 m, 30.3.1975, Wendelbo & Assadi 15291 (GB, TARI); west sides of road from Tehran to Qum, 5 km north of Kushk-e Nusrat, 1219 m, 31.3.1969, Hewer 905 (K); Elborz mountain, south side of watershed between Qazvin and Rasht, in rocky slopes, 625 m, 18.3.1962, Furse 1100 (K); Qazvin, Karaj, in mountain near the village Kalak, 1600 m, Rechinger 2746, 37594, (G, GB, W); Tehran to Arak, 41 km from Arak, 1350 m, 21.5.1993, Bakhshi Khaniki 32 (GB). – *Khorasan:* between Bojnurd and Shirvan, in clay, 1000 m, 20.4.1967, Rechinger 33182 (W); south east of Fariman, 1350 m, 21.4.1967, Rechinger 33204 (W); 62 km south of Sabzevar, road of Kashmar, 1500 m, 19.4.1976, Rejamand & Bazargan 31674 (W, TUH); Kuhhay-e Nishabour, 1800 m, 30.5.1948, Rechinger 7324 (W, TUH); 14 km east of Bojnurd, 980 m, 15.5.1966, Rioux & Golvan 7881 (G); Quchan to Sultanabad, stony slopes below igneous cliffs, 1800 m, 8.4.1964, Furse 5218 (GB, K); 24 km north of Quchan, Kopet Dagħ, in sandy calcareous soil among *Artemisia*, *Umbelliferae*, *Leguminosae*, 2000 m, 19.5.1966, Furse 7520 (K); Kopet Dagħ range, 30 km west of Darreh Gaz and 40 km north east of Quchan, on N-facing slope of immature rocky soil, 1900 m, 21.4.1871, Gibbons 56 (K); Torbat-e Haydariyah, Robat Safid, 1800–2000 m, 27.5.1948, Rechinger 4459 (W); Bojnurd, Chaman Bid, 1500 m, 19.4.1967, Rechinger 33179 (W); road from Bojnurd to Gorgan, before Rabatcharbil village, 1050–1250 m, 7.4.1993, Bakhshi Khaniki 4 (GB). – *Mazandaran:* Gorgan, Golestan forest, near Bojnurd road, along side road to Bakadeh, in *Artemisia*-steppe, 1250 m, 2.5.1974, Wendelbo et al. 11074 (GB, TARI), 1800 m, 2.5.1993, Bakhshi Khaniki 17 (GB); Gorgan, Shah Pasand to Shahrud, south side of pass, in *Artemisia* steppe, 3.5.1974, Wendelbo et al. 11141 (GB, TARI); 1950–1800 m, 18.5.1978, Wendelbo & Assadi 29678 (GB, TARI); Gorgan, towards Bojnurd, 106 km from Shahpasand, 1120–1300 m, 22.5.1976, Termeh & Matin 34889 (W, E). – *Azarbaijan:* 14 km south of Khoy on road to Shahpur, 1200 m, hills with sterile soil partly without vegetation, partly with *Artemisia*, 24.4.1976, Wendelbo & Assadi 19261 (GB,

TARI, TUH); 20 km south west of Jolfa on road to Evaghli, soil slopes, 1100 m, 22.4.1976, Wendelbo & Assadi 19236 (GB, TARI); 50 km after Zanjan on road to Tabriz, stony ground, 1350 m, 20.4.1976, Wendelbo & Assadi 19177 (GB); Khoy, on rocky hillside in full sun, 4000 m, Mathew in BSBE 519 (K); Tabriz, 1928, Gilliat-Smith 2212 (K). – *Hamadan*: Hamadan, south east of Rooan, 1845 m, among *Hultheimia* on low, rounded clay ridges, 11.5.1966, Archibald 1792 (GB); Aq Bulaq, c. 100 km north of Hamadan, 15.4.1960, Rioux & Golvan 11 (W, G); Aq Bolagh Morched, 60 km from Bijar, 24.4–10.5.1956, Schmid 6706 (G). – *Arak*: Arak to Golpaigan, 40 km east of Arak, 2031 m, 23.4.1962, Furse 1571 (K, W); Arak (Sultanabad), 20.5.1895, Strauss 49 (G).

**Afghanistan**: *Harat*: between Obbeh and Khodja Chist near Pardu Kham (bulbs cultivated at Göteborg Botanical Garden, Sweden), 10.5.1969, Hedge, Wendelbo & Ekberg, W-7771 (BG); Istalif, 3.4.1958, Lindberg 398 (BG); Salzak pass on road from Herat to Qala Nau, mountain at start of pass, stony slopes, 2150 m, 16.5.1969, Hedge, Wendelbo & Ekberg W-8075 (GB); Harat, 1400 m, 1.4.1949, Köie 3565 (W). – *Logar*: Logar valley, in wheat field, 18.4.1968, Jörgensen 450 (GB) – *Fariab*: near Kawlyan, east of Belcheragh, soil slopes, 1200 m, 26.5.1969, Hedge, Wendelbo & Ekberg W-8391 (GB) – *Baghlan*: Mirza Antibili pass, soil slopes, 1450 m, 31.5.1969, Hedge, Wendelbo & Ekberg W-8551 (GB) – *Zabul*: 20 km north-west of Shenkay, Qlati-e Ghilzai, 2170 m, 25.3.1971, Podlech 20094 (G) – *Urgun*: 35 km north-west of Urgun, towards Surmat, 2200–2400 m, 10.6.1967, Rechinger 35934 (W); Urgun, April 1970, Rechinger 88 (W) – *Kataghan*: Paigah Kotal, Pul-e Khumri, 1500 m, 5.5.1967, Rechinger 33942 (W) – *Chisht*: 1600 m, 20.4.1949, Köie 4289 (W) – *Kabul*: Istalif, north of Kabul, 1900 m, 3.4.1964, Neubauer 4025 (W); Logar valley, in steppes, 2.5.1951, Volk 1839 (W).

**Pakistan**: *Quetta*: Spin Karez, 1800 m, 31.3.1965, Rechinger 27340 (W); in jugo W Ziarat, 2200 m, 12.5.1965, Rechinger 29331 (W); between Qila Abdullah and Sheila Bagh, 1600–1900 m, Rechinger 29040 (W).

### 3.3b. *Rhinopetalum arianum* Los.-Losinsk. et Vved. (Fig. 1b)

Losina-Losinskaya & Vvedensky, Komarov, Fl. U.R.S.S. 4 (Addenda 3):738, 1935.

*Fritillaria ariana* (Los.-Losinsk. & Vved.) Rix, Iran. J. Bot. 1(2):82, 1977.

Type: “In arena mobili, in declivibus arenosis. Asiae Mediae” (n.v.).

Ic.: Losina-Losinskaya, Fl. U.R.S.S. 4:299, 1935.



## Description:

Bulb globose to subglobose, up to 2.5 cm diameter, consisting of two fleshy scales; bulbils or stolons absent. Stem 10–20–(40) cm, smooth, or papillose only below the lowest leaves. Leaves 8–10–(11), glaucous; the lowest 11–16 x 10–13 cm, linear-lanceolate, opposite to subopposite, acute; upper stem leaves alternate, linear; bract leaves 18–37 x 2–3 mm, linear, 2 at the base of each pedicel, of equal length, acute. Flowers 2–14, usually 5–7, horizontal at maturity, zygomorphic. Perianth segments 22–26 x 7–10–(11) mm, finely and irregularly pink-spotted rather than tessellated, usually yellow-spotted at base, ovate-lanceolate, acute; the inner somewhat wider. Nectaries placed ca. 0.5 mm above the base of the perianth segments, about 3–4 mm long at orifice, calcarate, the upper larger than the rest, the two lobes surrounding the nectary orifice very narrow, distinctly fringed and ciliate. Filaments 6–8 mm long, slender, papillose below. Anthers 2–3 mm, purple, ellipsoid; pollen sculpture rugulate. Style 5–7 mm long, slender, entire, glabrous, pale green. Ovary 4–5.5 mm long, 6-angled. Capsule 14–17 mm long, subglobose, winged, toothed at the top. Seeds unknown.

Chromosome number:  $2n = 24$  (Bakhshi Khaniki, 1998).

Flowering time: Early March–April.

Ecology and distribution: Sand dunes, shifting sands among halophytes and xerophytes, and dry slopes, ca. 1000 m. Also known from Turkomania and Afghanistan.

*Rhinopetalum ariananum* is known only from one collection in Iran, Khorasan, Torbat-e Jam, near Hari Rud, where it grows in sandy steppes. It is very close to *Rh. gibbosum* and *Rh. karelinii* Fisch. ex D. Don in aspects of nectary features, papillose filaments and styles, and also in having zygomorphic flowers, but it differs from both by having untessellated perianth segments, and shorter filaments and styles. Moreover, the basal leaves are somewhat narrower than in *Rh. gibbosum*. The stem in *Rh. arianum* is glabrous, or papillose only below the lowest leaves, while that of *Rh. karelinii* (Fig. 2) and *Rh. gibbosum* is papillose throughout.

## Specimens Examined:

**Iran:** *Khorasan:* Torbat-e Jam, Salehabad, near Hari Rud, associated with halophytes and xerophytes, c. 1000 m, 21.4.94, Bakhshi Khaniki 42 (GB);

**Afghanistan:** *Maymana:* half way between Andkhui and Maymana, slopes rich in annual vegetation at margin of semidesert, 25.5.1962, Wendelbo 3579 (BG, K);



**Turkomania:** *Ashkhabad:* Between Annaju and Gjaurs, south of Kara-Kumov, Nikitin (JE,W); Ashkhabad, 16.3.1898, Litwinow 2081 (W).

#### ACKNOWLEDGEMENTS

I wish to thank Dr. Karin Persson and Prof. Lennart Andersson for reading of the manuscript, constructive criticism and helpful suggestions.

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*ZEPHYRANTHES GUATEMALENSIS* L.B. SPENCER

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FIELD ACCOUNT

In July 1990, I accompanied IBS members T. Howard and J. Kersey on a plant expedition in Guatemala. We traveled widely in a rented vehicle as we sought to locate various indigenous-bulbous plants, including *Hymenocallis*, *Sprekelia*, *Crinum* and *Zephyranthes*. One specific bulb we hoped to find was *Zephyranthes guatemalensis* L.B. Spencer. The latter was a little known species indigenous to the ancient Mayan ruins at Iximché. This archeological site lay nestled within a piney forest in the central highlands at an altitude of approximately 2000 m. Only recently had the bulb been described and recognized as a distinct species (Spencer, 1986). Unfortunately, no drawings or photographs accompanied Spencer's description. However, it had once been figured in *Flowers of Guatemala* (Chickering, 1973), having been identified under the caption *Zephyranthes brevipes*; the figured bulb had been collected at Iximché.

When we arrived at Iximché, we immediately spied several bulbs of a non-flowering *Zephyranthes* growing near the base of a pine tree in the unpaved parking lot. We toured the ruins (Fig. 1), but not once did we observe another *Zephyranthes* within the grounds of the ruins. Then we began to explore the piney forest adjacent to Iximché, and soon we came upon clusters of non-flowering *Zephyranthes* growing within a thick carpet of pine needles, the latter perhaps 5–6 cm thick (Fig. 2). We did not see any evidence of recent or remote flowering. The bulbs were growing in a loose organic soil, and the area was heavily shaded. Sadly, as we were photographing the bulbs and collecting a few specimens, there were loggers immediately about us actively harvesting the pine trees. Whether or not the locality was in danger of habitat destruction, we did not know; however, the latter possibility seemed rather unlikely as the logging operation appeared to be a primitive endeavor that lacked heavy industrial equipment.

Regarding the remainder of the trip, which lasted an entire week, I have briefly summarized a few of the interesting highlights from my diary. One day we drove south of Guatemala City, passing through Escuintla and headed towards the El Salvador border. Howard knew approximately where



Fig. 1. Mayan ruins at Iximché, Guatemala, on a very overcast day, 26 July, 1990. All photographs by the author.



Fig. 2. *Zephyranthes guatemalensis* L.B. Spencer in natural habitat near Iximché, Guatemala, 26 July, 1990. There are two clusters of bulbs with slender, erect green leaves in the central clearing.



*Hymenocallis tenuiflora* was reported to be indigenous. Beyond the city of Taxisco, the road was in terrible condition, literally just full of potholes, and it was easier to drive on the shoulder of the road. We found the bulbs at two sites, 15 km and 25 km south of Taxisco, growing in grassland fields about small ponds in swampy gumbo soil. None were in flower. Only later did we learn that only a few weeks beforehand, there had been an attempted political assassination along the very road we had been driving south of Taxisco. Of course we were assured that the Guatemalans settled matters between themselves and did not bother the tourists. Hah!

Following our adventure at Ximché, we drove west to Chichicastenango for lodging. While there, we toured a very old, rather fascinating Catholic church. Several unusual features stood out. There were rectangular stone alters with flat surfaces positioned at central locations in the main aisle and near the alter, and these we were informed were strewn with cut flowers during certain ceremonies. In the rear portions of the church, there were many old, near life-size statues depicting the Spanish Conquistadors (in full armor) bringing Christianity to the native peoples. The Conquistadors were frequently riding horses, and one was leading Jesus riding on a mule, while small figures of native peoples were positioned about the animals, looking upward with adoring eyes at Jesus and at the Conquistadors.

We had hoped to find *Crinum erubescens* near Puerto Barrios in tributaries of rivers flowing into the Caribbean, but we had no luck. We did observe a few *Crinum* in cultivation as well as ones that had escaped cultivation at various locations, including: *C. zeylanicum*, *C. amoenum*, *C. x augustum*, and *C. 'Empress of India.'* South of Coban, we encountered multiple plantings of *Zephyranthes grandiflora*. Not once did we spy *Sprekelia*, and Howard was disappointed that the only indigenous *Hymenocallis* we found was *H. tenuiflora*.

No visit to Guatemala would have been complete without going to Antigua – a city located beside the beautiful lake of Atitlan that is surrounded by mountains and inactive volcanoes. What spectacular scenery! Fortunately we were able to find lodging, because the city was over run with tourists (it is a popular vacation resort, especially with Europeans).

## HORTICULTURE

Cultivating *Z. guatemalensis* has had some disappointments in Southeast Texas. The bulbs do grow vigorously, and they occasionally offset. However, bulbs bloom infrequently and rather sporadically during the late



Fig. 3. *Zephyranthes guatemalensis* L.B. Spencer in bloom, cultivated in Southeast Texas.



Fig. 4. *Zephyranthes guatemalensis* L.B. Spencer in bloom, cultivated in Southeast Texas.



Fig. 5. *Zephyranthes guatemalensis* L.B. Spencer in bloom, cultivated in Southeast Texas.



spring and summer (Fig. 3, 4, 5), and they do not respond in unison to rain showers as other *Zephyranthes* that I have in cultivation. Also, to date these bulbs have not been self fertile. On the few occasions when two bulbs have bloomed simultaneously, cross pollination has yielded only a few viable seeds per fruit. The flowers though are attractive and long lasting, usually three days in my hot and humid summer climate. The petals slowly elongate to some degree between days one and three of the flowering period.

I have attempted to simulate the indigenous habitat, providing bulbs with a dry dormant period to mimic the distinct dry winter characteristic of the central Guatemalan highlands, and each year I place a fresh layer of pine needles on top of the pot – presumably the latter creates an acid soil during decomposition and may provide certain essential nutrients. Perhaps the prevailing summer temperatures in Southeast Texas are too hot for optimal flowering and fertility of this species. Also there is a great disparity in altitude as I reside at 8 m above sea level, far below the altitudes occurring in the highlands of Central Guatemala. No attempts at interspecific hybridization have been successful to date.

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## CONVERSATION POLICY STATEMENT

The following policy statement was developed by an international consortium which included the representatives of the International Bulb Society, Alpine Garden Society (UK), North American Rock Garden Society, Chicago Botanic Garden and American Daffodil Society.

The total populations and diversity of many plant species across the world are in decline. Habitats are faced with increasing threats of destruction as mankind continues to develop the environment for urban, agricultural and recreational uses.

Plant societies are dedicated to understanding, preserving, growing, selecting, propagating and appreciating the natural flora of the earth. As plant enthusiasts, we share a responsibility to embody the principles of conservation in such a way that our activities as gardeners, horticulturists and botanists are in harmony with the wider concerns of preserving the environment.

Collection of plant material from the wild has left some species of plants facing extinction. The memberships of the undersigned organizations have agreed to abide by the following Code of Best Practice:

- We strive to support organizations that seek to preserve valuable wildlife habits as the sources for genetic variations and naturally thriving plants for generations to come.
- We do not support the practice of wholesale collection for resale of wild plants from their natural habitats. We condemn the practice of misleading the public by calling such collected plants nursery grown or nursery propagated.
- We support the practice of collection of seeds, cuttings, divisions, and the occasional selected individual from large populations of wild plants by knowledgeable and responsible individuals for the purposes of growing, studying, selecting, hybridizing and ultimately propagating and distributing such material to others.

Our support is tendered only where the value of such collection lies in scientific research, preparing herbarium records or propagating such material for horticultural or conservation purposes, and is further based upon the provisos that:

- Discretion is exercised in collecting seed, such that only part of the seed productions is taken.
- Living material is collected only in small amounts.

- In the case of rare plants, material is collected only upon a very limited basis and only where there is sufficient local stock to successfully perpetuate that population.
- We encourage our members to familiarize themselves with and comply with national and local legislation or regulations regarding the conservation of habitats and the collection of plant material.
- We support the sentiments of the various international conventions, such as CITES and the Biodiversity Convention.
- We welcome like-minded organizations to agree to follow this Code of Best Practice.

Schedules: Each plant society or conservation organization is encouraged to list species or classes of plants whose dwindling populations are of imminent concern to them. In this way, all groups can be guided by the knowledge of the specialists and share their concerns.

Adopted by International Bulb Society, July, 2000

Adopted by American Daffodil Society, November, 2000

Adopted by North American Lily Society Board, January 2001



## CONTRIBUTOR'S GUIDELINES FOR HERBERTIA

**Herbertia** is an international journal devoted to the botany and horticulture of geophytic plants. A special emphasis of the journal is the Amaryllidaceae and other petaloid families rich in bulbous, cormous or tuberous plants, but articles treating any aspects of geophytes are welcome. Articles may be formal (scientific), informal (practical, informative), field reports, historical accounts, addendum notes, and timely reports of Society activities. Contributors are asked to adhere to the following guidelines when submitting papers. Manuscripts departing grossly from this format will be returned to the author(s) for revision.

1. Scientific or technical articles (e.g., taxonomy, plant physiology) submitted for publication in **Herbertia** will often be sent to an appropriate reviewer for peer review. Any article may be scrutinized for accuracy by an appropriate reviewer. Final decision for "acceptance" or "acceptance with revision" of manuscripts resides with the Editor; authors of rejected articles may appeal the decision to the IBS Board of Directors.
2. Manuscripts **must** be typed or produced with legible ink jet or laser printers on 8 1/2 x 11 inch paper. Double spacing should be used throughout.
3. An electronic copy of the manuscript **must** accompany the written copies. This should be provided on a CD/DVD or sent to the Editor as an e-mail attachment. Microsoft Word for Windows versions 6, 7, 97, 2000 and XP are preferred.
4. Scientific papers may be prefaced with a short abstract if appropriate and so desired.
5. Descriptions of taxa should follow conventional form as to construction of descriptive paragraphs, specimen citation, and synonymy. Use the following examples as a guide or consult journals such as *Systematic Botany*, *Brittonia*, or *Annals of the Missouri Botanical Garden*:

*Callipsyche aurantiaca* Baker. Refug. Bot. 3:t. 167 (1869). Neotype: Ecuador, El Oro, Ayabamba, 200 m, Andre 4262 (K).

*Eucrosia morleyana* Rose. Addisonia 7:3-4, pl. 226 (1922). Type: Ecuador, Chimborazo, Huigra, 4000 ft, Rose & Rose 22593 (holotype, US; isotypes, GH, NY, S).

*Eucrosia eucrosioides* var. *rauhiana* (Traub) Traub. Pl. Life 22:62 (1966).

*Callipsyche eucrosioides* var. *rauhiana* Traub. Pl. Life 13:61 (1957). Type: Ecuador, Azuay, Pasaje, 300 m, Rauh & Hirsch E15 (holotype, MO)

Bulb large, 7.7-10 cm long, 6-7.7 cm in diameter; tunics tan-brown; neck (2.5)-5-8 cm long, 2-2.6 cm thick. Leaves 2, hysteranthous; petiole 27-35 cm long, 7.5-10 mm thick, deeply channelled for most of its length; lamina ovate-elliptic, 29-40-(50) cm long, (12)-16-22 (29) cm wide, acute or short-acuminate, basally attenuate to the petiole, thick, coarsely undulate, hypostomatic, abaxial cuticle thickly striate and non-glaucous. Scape (5)-7-9(10) dm tall, ca. 10 mm in diameter proximally, ca. 4-6 mm in diameter distally; bracts 3-(5) cm long, lanceolate. Flowers (7)-10-12 (13), zygomorphic, all reaching anthesis concurrently, more or less perpendicular to the axis of the scape; pedicels (11)-22-33 mm long, 1-2 mm in diameter; perianth (2.8)-3-4-(4.4) cm long, green in bud, yellow at anthesis, rarely orange or pink, compressed laterally giving the perianth a somewhat flattened appearance; tube sub-cylindrical, 5-7 mm long, ca. 5-6 mm wide, constricted at the ovary to ca. 3.8 mm wide, concolorous with the tepals for most of its length, green only at the base; tepals spreading dorsally and ventrally to 23-29 mm wide, recurved and sometimes stained green apically; outer tepals (20)-23-29-(36) mm long, 5-6 mm wide, apiculate, lanceolate, keeled, 2 of them situated laterally, one dorsally; inner tepals 20-26-(34) mm long, obtuse, oblanceolate-spatulate, margins undulate at the middle, 2 of them ca. 9.5 mm wide and situated laterally above the 2 lateral outer tepals, the third one 5-7 mm wide, ventrally declinate and with the lower lateral tepals forming a pseudo-labellum. Stamens subequal, 8.5-11 cm long, filiform, long-declinate, ascendent in their distal 1/4, green; filaments dilated and connate in their proximal 2-3 mm; globose nectar glands present at the perianth throat, each 1-2 mm in diameter; anthers 5.5-6 mm long, oblong; pollen green, the exine mostly tectate-perforate. Style 10-11 cm long, green; stigma less than 1 mm wide. Ovary ellipsoid, 6.5-9 mm long, 4-4.5 mm wide; ovules 20 or more per locule. Capsule 2.5-3 cm long, 17-22 mm in diameter; pedicel 5-6 cm long; seeds numerous, blackish-brown, ca. 6.5 mm long, 1.5 cm wide. 2N = 46. Flowering July-September and December-January.

**Ecuador.** El Oro: between Santa Rosa and La Chorita, 0–100 m, Hitchcock 21139 (GH, NY, US). Chimborazo: Río Chanchan canyon between Naranjapata and Olimpo, terrestrial in rock wall crevices, 800 m, (ex hort), Horich ISI # 214 (UC). Between Huigra and Naranjapata, 600–1200 m, Hitchcock 20638 (GH, NY, US). Cañar: valley of Río Cañar near Rosario, 960 m, Prieto CP-18 (NY, S). Azuay: Road from Jiron to Pasaje, near Uzhcurrumi, dry, steep, rocky hillside, 840 m, Plowman et al. 4600 (GH), Plowman 7634 (F), Plowman 12024 (F). Km 97 on road from Cuenca to Saraguro, dry thorn scrub, ca. 1100 m [incorrectly typed on specimen label as 2400 m], Madison et al. 7517 (SEL). - Inhabiting semi-desert and dry, rocky canyons and hills of the lower inter-Andean valleys (100)–300–900–(1100) m. Endemic.

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## NOTES

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# HERBERTIA

Journal of the International Bulb Society

**VOLUME 60**  
**2005–2006**



**International Bulb Society**

P.O. Box 336

Sanger, CA 93657 USA

<http://www.bulbsociety.org>

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ISSN 1559-8772

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## EDITOR'S COMMENTS

Two of the Society's recent Herbert Medalists, Dr. August De Hertogh (2000) and Dr. Marcel Le Nard (2003), are well known to many IBS members through a book they co-edited: *The Physiology of Flower Bulbs*, published by Elsevier Science Publishers B.V. in 1993. Could it be more than a mere coincidence that the 2006 Herbert Medalist, Dr. Abraham H. Halevy, co-authored a chapter in the latter book? Dr. Halevy has published a few books of his own. His "bibliography" is most impressive.

The 2006 Traub Awardee, Mrs. Pamela J. Kelly, provides us with only a modest account of her life and her service to the Society. But for those of us who have been on the Board of Directors and the Awards Committee for a period of time, we know that she "saved" the Society from ruin. Fortunately for the Society, she discovered regulations regarding the State of California and the Internal Revenue Service that were unknown to the rest of the Board of Directors, and she filed the pertinent reports and salvaged the Society's non-profit, tax-exempt status.

Regarding the content of this volume, Fritsch et al provides us with an account on *Allium* and their medicinal properties, possibly the first article in *Herbertia* devoted to medicinal bulbs and the identity of their active ingredients. Charles Craib, a long time IBS member and contributor to *Herbertia*, continues with his field accounts on rare and unusual geophytes from Southern Africa. Many of Craib's investigational reports represent the only thorough field reports in the literature on the subject plants. And then we have three *Crinum* accounts – what would an issue of *Herbertia* be without articles on this taxon?

And finally, I wish to acknowledge and to thank Alan Meerow and Victor Lambou for their contributions in editing and organizing this publication.

—David J. Lehmiller, Editor

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## THE HERBERT MEDAL



The Herbert Medal is the highest honor that the International Bulb Society can bestow upon a person for meritorious achievement in advancing the knowledge of bulbous plants. The medal is named for William Herbert (1778-1847), son of Henry Herbert, Earl of Carnarvon. William Herbert had a predilection for amaryllids and achieved success in their hybridization. He published his research findings in several monumental works. His contributions as a pioneer geneticist and plant breeder, and his arrangement of the Amaryllidaceae, helped set the stage upon which other workers, both amateur and professional, have been able to advance.

The Herbert Medal may be awarded annually or on special occasions by the Board of Directors of the Society. Candidates for the Medal are recommended to the Board of Directors by the Awards and Recognition Committee. Medalists need not be members of the Society to be considered for the Herbert Medal. The award includes honorary life membership in the Society.



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2006 HERBERT MEDALIST

DR. ABRAHAM H. HALEVY



## ABRAHAM H. HALEVY

### AUTOBIOGRAPHY

I was born in 1927 in Tel-Aviv, Israel and had my primary and secondary education in this town. After graduating from high school, I joined an agricultural kibbutz (a collective community) where I worked for three years with several horticultural crops. I then joined the Israel Defense Forces and fought (and was injured) during Israel's War of Independence. After the war I studied biology and horticulture at the Hebrew University of Jerusalem and obtained with distinction my M.Sc. (1955) and Ph.D. (1958) in Plant Physiology and Horticulture. The Hebrew University authorities offered me a fellowship if I would conduct my postdoctoral work in citriculture and later join the Citrus Department of the University. At that time, citrus was Israel's most important horticultural crop for export, floriculture was not taught at the Faculty of Agriculture of the Hebrew University, and there was virtually no serious floriculture in Israel. I declined the offer to work on established crops such as citrus and decided to try to establish an ornamental industry including teaching and research at the University.

I therefore, in 1958 applied for and was accepted as a Research Fellow in the Ornamental Crops Department of the USDA in Beltsville, MD, where I worked for one and a half years with great scientists such as Harry Borthwick, Sterling Hendricks, Neil Stuart, Marc Cathey, Sam Asen and others. When I returned to Israel and the Hebrew University at the end of 1959, I had to teach plant physiology and citriculture, but I also started offering "voluntary" courses in floriculture and commenced my research program on floral crops. In 1964 the University approved floriculture as a legitimate line of teaching and research. I founded the Department of Ornamental Horticulture at the Hebrew University and served as Head of the Department for twenty-two years. Actually, this was the beginning of the floriculture industry in Israel that developed from almost nil in the early 60's to an annual export value of over US\$350M today. Our graduates, being the major researchers, extension officers, growers and exporters, were mainly those who built this industry.

In 1964/5 I was a Visiting Professor at Michigan State University, East Lansing, and during the 70's, 80's and until 1993, I served as a Visiting Professor on sixteen occasions in the Department of Environmental Horticulture of the University of California, Davis.



Although I have been officially retired for almost ten years, I continue maintaining my laboratory and research greenhouses, as well as guiding graduate students and following my research almost as before. During my scientific career I published over 350 scientific papers in reviewed international journals, which about 120 of them are on bulbous crops (see enclosed "List of Publications on Bulbous Plants"). I also published 5 books, among them the 6- volume treatise "Handbook of Flowering" (1985-1989), which is still the most comprehensive book on flowering. I founded the International Working Group on Flowering (1985) and issued and edited its scientific journal for four years. My main three lines of research activities focused on: (a) physiology of flowering and developing practical methods for control of flowering; (b) postharvest physiology of flowers, and (c) introduction and development of new florist crops. Initially I worked mainly on geophytes: gladiolus, iris, ornithogalum, tulip, native geophytes, but still the study on the physiology and culture of bulbous plants constituted an important part of my work.

Over the years I received several awards: In 1983 I was nominated a Fellow of the American Society of Horticulture. In 1999 I was elected a member of the Norwegian Royal Academy of Science and Letters. Volume 8 of "Horticultural Reviews" (1986) was dedicated to me. In 2002 I was awarded the "Israel Prize", the highest prize for contributions to science and society in Israel. In 2003 I received an Honorary Doctor of Science from the University of Waterloo, Canada. And last, but not least, the Herbert Medal of the International Bulb Society.

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## 2006 TRAUB AWARD

MRS. PAMELA J. KELLY



MRS. PAMELA KELLY

### AUTOBIOGRAPHY

I was born in San Francisco and lived in California and Oregon while growing up. My father worked for the U.S. Forest Service, and he was transferred about every 1-2 years until we settled in Fresno, California. Here I finished school, married Herbert Kelly Jr. and raised 3 children, Timothy, Susan and Catherine. We now have 4 grandchildren;

I was the Office/Credit Manager for JM McDonalds Department Store, before working as an Accounts Receivable for the local PBS TV station.

### IBS SERVICE:

1. 1978-1983: American Plant Life Society, helped create an index of Plant Life and Herbertia for Dr. Hamilton Traub.
2. 2002: Assisted in organizing the IBS Symposium at the Huntington Library, Art Collections and Botanical Gardens.
3. 2002-Present: IBS Treasurer.



## MORE THAN A PRETTY FACE - ORNAMENTAL “DRUMSTICK ONIONS” OF *ALLIUM* SUBG. *MELANOCROMMYUM* ARE ALSO POTENTIAL MEDICINAL PLANTS

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### SUMMARY

Many members of *Allium* subg. *Melanocrommyum* are cultivated as ornamentals in European and North American gardens. Most of these species occur naturally in Southwest and Central Asia where they are collected in nature and used as vegetable, spice, and medicinal plants by the local people.

Eighteen species reportedly used as medicinal plants were morphologically and taxonomically characterized. Most of these species were chemically analyzed and also screened for radical scavenger activity. Our data verified relatively large amounts of cysteine sulfoxides (the main, medicinally-active sulphur compounds of garlic and common onion) to be present in ten species. However, some highly valued species also showing a very high radical scavenger activity contained only traces of cysteine sulfoxides; these species contained significant amounts of the newly detected sulphur pyrrole. This latter compound was apparently responsible for the high radical scavenger activity. Unexpectedly, three species showed high scavenger activity but did not contain remarkable amounts of either cysteine sulfoxides or sulphur pyrroles. These data underlined that another bioactive principle might be present, and more species of subg. *Melanocrommyum* than hitherto used may represent valuable medicinal plants.

### 1. INTRODUCTION

*Allium* is one of the largest genera of the monocots (currently at least 780 species) and extremely diverse. The newest taxonomic classification (Friesen et al., 2006) accepts 15 subgenera, and subg. *Melanocrommyum* (Webb et

Berth.) Rouy is one of the largest containing about 140 species. Many members of this and other subgenera have a striking appearance, having been introduced as ornamentals into the gardens beginning in the 19th century. A steadily growing number of named cultivars (selections as well as hybrids) are offered by the traders of ornamental bulbs. Some widely cultivated, spicy *Allium* species like chive, Chinese chive, rakkyo, Great-Headed garlic, as well as some more rarely cultivated ones also possess ornamental properties. They are mostly rather small plants but bear conspicuous head-like inflorescences during anthesis.

In the scientific literature, medicinal applications by the local population of their home countries have been reported for several *Allium* species, which are cultivated as ornamentals in Europe and North America (for details see Keusgen et al., 2006, Fritsch et al., 2006).

Most members of the genus *Allium* have specific tasteful properties thus making them powerful spice plants. Spicy onions are well known to contain one or more cysteine sulfoxides as precursors of the main active principles and show a remarkable correlation: the most intensely tasting and smelling species contain most of these compounds, mostly alliin and isoalliin, and they are also those with the strongest health-supporting and medicinal effects (Keusgen, 2002; Fritsch and Keusgen, 2006). Other substances like steroid saponins and different sugars (mono-, di- and polysaccharides) are also present in remarkable amounts (Sokolov, 1994; Keusgen, 2002) and contribute to taste, odor as well as medicinal activity of these species. Therefore, the term "nutraceutical", which means food with a supporting medicinal (healing or protective) effect, fits *Allium* species perfectly.

Surprisingly, only very few ornamental *Allium* species of the subg. *Melanocrommyum* possess an onion or garlic-like taste and odour. Screening on cysteine sulfoxides usually shows low to very low relative contents also in spicy smelling species (Fritsch and Keusgen, 2006). Only a few exceptions occur. This also holds true for those species, which are reportedly collected for general tonic properties or for specific medicinal applications. Thus, another active principle should also be present.

## 2. MATERIAL AND METHODS

Original information was gained during joint research missions with Tajik, Uzbek, and Iranian cooperation partners from 2003 till 2006. In the areas of interest, at first *Allium* plants were collected in nature, and then shown to the native people, which were interviewed in their native lan-

guages asking about the local name, possible use, and mode of application of these plants. Afterwards, the presented plant material was planted in the national Tajik, Uzbek, or Iranian *Allium* collections, where also herbarium voucher specimens were taken if possible (for more details and addresses of these collections see Keusgen et al., 2006, Fritsch et al., 2006). A part of the original material was taken to Marburg University, Germany, where the content of cysteine sulphoxides was determined and bio-activity was tested. Because drying of bulbs causes indeterminable losses of cysteine sulphoxides, fresh plant parts were extracted with methanol or with ethyl acetate. In contrast, leaf material could be dried by moderate heat (up to 60 °C) within 14 hours. Radical scavenger activity was spectrophotometrically measured (at 517 nm or 540 nm) in a 1,1-diphenyl-2-picrylhydrazyl (DPPH) solution as substrate with butylated hydroxytoluene (BHT) as reference using microtiter plates (details see Jedelská et al., 2004). The contents of the above mentioned four cysteine sulphoxides were separately measured in form of ortho-phthaldialdehyde (OPA) derivatives at 335 nm by HPLC-separation using Spermarge 80-ODS2 RP column (5 µm particle size; 250 x 4 mm with integrated guard column) operating at a flow rate of 1.0 ml/min (details see Fritsch and Keusgen, 2006).

Duplicates of some accessions were also transferred to the Taxonomic *Allium* Reference Collection of the Leibniz-Institute of Plant Genetics and Crop Plant Research (IPK), Gatersleben, Germany, to be re-determined if necessary. Here leaves of all available accessions per species were tested as to whether they exude a red sap as described above.

We compared our results against data from literature as far as available. However, it was impossible to study all original publications (mostly in Russian with difficult access). Therefore, some data were cited from review papers only (e.g. Sokolov, 1994). Unfortunately, nearly all cited references do not mention the offspring of investigated materials, and no information could be gained about presence and housing of voucher specimens, photographs, or other data characterising the material in a taxonomic sense. This was a strong drawback considering the complicated *Allium* taxonomy and significantly differing principles of classification and naming of taxa. In the case of contradictorily data from literature, we had the impression that incorrect botanical determinations may be the reason but cannot give proof.





Fig. 1. *Allium akaka*, bulb from Khalkhal, northern Iran.



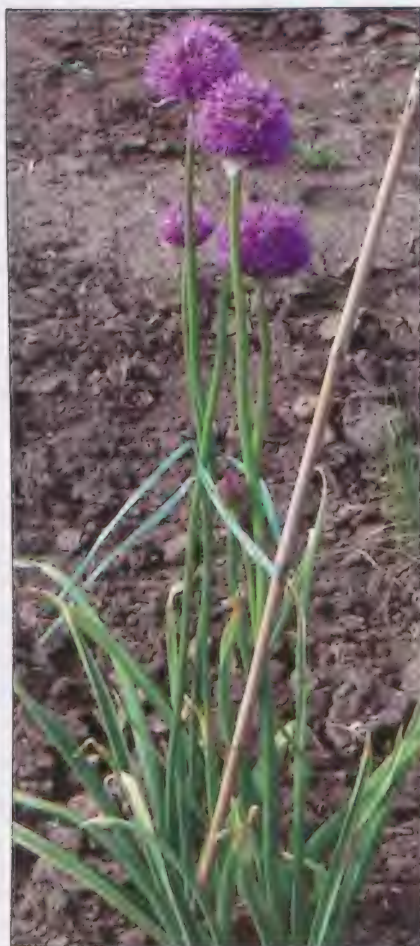


Fig. 2. (Left) *Allium macr.*; bulbs from Chimgan Mountain Range, Uzbekistan.



Fig. 3. (Right) *Allium severtzovioides*, bulbs in Ugam Mountain Range, Uzbekistan.

### 3. RESULTS

#### 3.1 Taxonomic characterization and reported medicinal use of different species.

##### a) Sect. *Acanthoprason* Wendelbo

About 20 species of rather small plants but with dense fasciculate or semi- to sub-globose dense inflorescences belong to this mainly Southwest-Asian section. Most characteristic are the tepals which are longitudinally enrolling after anthesis and may become stiff and prickly when completely dry. The leaves are generally much longer than the scape.

*Allium akaka* S. G. Gmel. ex Schult. et Schult. f. s. l. "Valak" (Persian)

This name is taxonomically still somewhat unclear, but most often it is applied for stout broad-leaved plants (Fig. 1) distributed in the mountains of northern Iran and the adjacent Turkish and Transcaucasian territories. This taxon grows on sunny rocks and stony slopes.

Young to flowering plants are eaten as vegetable and are applied against rheumatism and other pains. Inflorescences pickled in vinegar are used as a special spice "torshi". Thus *A. akaka* is a typical "nutraceutical" being used as a vegetable and spice with medicinal properties. The plants and the inflorescences are offered in such large amounts at the markets as observed in Tehran (Fritsch et al., 2006) that populations of this species are probably endangered by over-collecting already.



Fig. 4. *Allium costatovaginatum*, bulb from Chatkal Mountain Range, Uzbekistan, showing the ribbed sheath leaf.





Fig. 5. *Allium sinucrenatum*, a population growing near Panj River, Tajikistan.



Fig. 6. *Allium chitralicum*, bulb from Yazgulem Mountain Range, Tajikistan.

b) Sect. *Acmopetala* R.M.Fritsch

This variable section contains mainly tall “drumstick-onions” with globular dense flower heads and leaves much shorter than the scape. Often the tepals are long tapering and the mid-vein is ending below the tip.

*Allium motor* Kamelin et Levichev “Motor, moy - modor “ (Uzbekistan; the term ‘motor’ means “health”)

The natural area of distribution of this tall species (Fig. 2) is rather small comprising only the Chatkal mountain range in Uzbekistan and adjacent Kyrgyz and Kazakh territories. Here it grows on shady slopes among bushes and is easily recognized by a smooth, thin, and quickly decaying sheath leaf.

The leaves are much collected in April and May. They are freshly used as stuffing for a special variant of the national pie dish ‘somsa’ which is highly esteemed for a specific activity as tonic. However, application is problematic for persons having high blood pressure (Umarov, 1992, Keusgen et al., 2004, Keusgen et al., 2006). The use of “motor” became known from people living in the Kirgiz territory of Chatkal mountain range during the 1970’s, first in





**Fig. 7.** *Allium komarowii*, bulbs from Turkestan Mountain Range, Tajikistan.

the Parkent area of Uzbekistan (Umarov, 1992). Today also this species is much collected for consumption and has become rare in some areas.

Because leaves of other *Allium* species look similar, people collecting "motor" must know the two 'signs of authenticity' of the true species: a reddish liquid coming out of the damaged tissue of freshly plucked leaves, and a special soft structure of the leaf tissue which is tested by chewing a piece of leaf.

*Allium severtzovioides* R.M. Fritsch "Tosh - motor" (Uzbekistan)

This species is closely related and very similar to *A. motor* occurring in the same geographical region. However, plants of *A. severtzovioides* grow larger and prefer more sunny slopes (Fig. 3). It can easily be differentiated from *A. motor* by an elongated, strong, and very coarse sheath leaf.

Fresh leaves and bulbs without stems are locally applied against stomach and duodenum diseases (Keusgen et al., 2006) and as a mild tonic (Umarov, 1992). The fresh leaves of "tosh - motor" do not show reddish liquid, and the tissue is remarkably harder (the local name can be translated as 'hard motor').

*Allium costatovaginatatum* Kamelin et Levichev.

The same local name as for the previous species and use was mentioned for this related species (Umarov, 1992). These are smaller plants having a strong sheath leaf bearing a few conspicuous ribs (Fig. 4); they occupy dry stony slopes of the Chatkal mountain range.



Fig. 8. *Allium jesdianum* s. str., bulbs from Deh Balla, Iran.





Fig. 9. *Allium jesdianum* s. lat., bulb in Shahr Masiv, northwestern Iran.



Fig. 10. *Allium roseorum*, bulbs from Hissar Mountain Range, Tajikistan.



*Allium suworowii* Regel “Niyazi ansul, piozi anzur, yovvoji pioz”  
(Uzbekistan, Tajikistan)

This variable species occurs in all Central Asian republics. The plants often reach more than 1 m height and grow on open slopes (Fig. 5) and in grassy disturbed areas along roads and other ruderal areas. Most characteristic are fibrous, elongated, and spirally coiled bulb tunics, an intense unpleasant odour of all plant parts, and glossy (like polished) ovaries.

In Uzbekistan and Tajikistan young bulbs are pickled and used as spicy vegetable (Dadabaeva, 1972, Khassanov and Umarov, 1989) and also in folk medicine against internal and lung diseases, early forms of tuberculosis, and

bronchitis (Sakhobiddinov, 1948, Vvedensky, 1963, Khalmatov, 1964, Sokolov, 1994). In the Darvaz mountain range of Tajikistan, decoctions of flowers and seeds are applied against headache and cold (Keusgen et al., 2006).

#### c) Sect. *Brevicaule* R.M. Fritsch

This small section contains only three rather small species showing variable leaf and flower characters, and these taxa may not represent a natural group.

*Allium chitralicum* Wang et Tang s. str.  
(*A. pauli* Vved., *A. badakhshanicum*  
Wendelbo) “Siri kuhi” (Tajikistan)

Contrary to most other species mentioned in this paper, the plants are rarely higher than 20 cm, possess one or two leaves somewhat longer than the scape, and a small spherical head of white flowers (Fig. 6). They are growing on moist slopes of higher mountain areas in northern Afghanistan, adjacent Tajikistan, and north-western Pakistan. It is a rare species not much collected for use.



Fig. 11. *Allium rosenbachianum* subsp. *kvakense*, bulbs from Botanic Garden Dushanbe, Tajikistan.



Fig. 12. *Allium sarawshanicum*, bulbs from Hissar Mountain Range, Tajikistan.





Fig. 13. *Allium stipitatum*, bulbs in an abandoned vineyard near Hamadan, Iran.



Fig. 14. *Allium nigrum*, pink flowering form from Botanical Garden Leipzig, Germany.

Medical usage is only known from Tajikistan where smashed bulbs are used against a sense of fear. The whole plant is also used as vegetable for the national dish 'atolla' (Keusgen et al., 2006).

d) Sect. *Compactoprason* R.M. Fritsch

Tall species especially imposing by extraordinary dense globular flower heads belong to this section. The anthesis may last 20-30 days. The leaves of the well known ornamentals *A. giganteum* Regel and *A. macleanii* Baker are consumed as vegetables, but medicinal use was not reported.

*Allium komarowii* Lipsky "Gushi gurgak, khujrak-motor" (Tajikistan)

This species combines broad thick glaucous leaves like the below mentioned *A. karataviense* with a dense globe of scarlet flowers on a rather tall





Fig. 15a. (Top) *Allium karataviense*. Population on a rubble slope near Panj River, Tajikistan.  
Fig. 15b. (Bottom) Bulb with red flowers from Angren Valley, Uzbekistan.



Fig. 16. *Allium koelzii*, bulb in Zagros Mountain Range near Kermanshah, Iran.





Fig. 17. *Allium hissaricum*, bulbs from Hissar Mountain Range, Tajikistan.

scape (Fig. 7). However, it is not such a striking ornamental like *A. giganteum* and *A. maclearii*. It occurs in the Turkestan and Hissar mountain ranges of northern Tajikistan and adjacent regions of Uzbekistan and Kyrgyzstan.

*Allium komarowii* is believed to have a rather strong medical power. Leaves and bulbs are used fresh, or cut in pieces and cooked and applied against anaemia and bad circulation, and beyond it as anabolic drug for horses (Keusgen et al., 2006). Cysteine sulphoxide content of the bulb is low but high in the leaves (Table 1). This species contains also the above mentioned red dye (Table 2).

e) Sect. *Megaloprason* Wendelbo s. str.

This section also comprises tall species, but the globular pink to purple flower-heads are only moderately dense and show a much shorter duration of anthesis. Species showing prominently ribbed scapes in the living state occur only in this section of subg. *Melanocrommyum*. The flowers of several species like *A. rosenbachianum* of gardens and *A. stipitatum* are conspicuously colored and are well-known ornamentals, but the flower heads of other ones are rather inconspicuous. Generally, the flower characters of all members of this section show a very similar variation pattern and cannot be used for simple differentiation between the taxa.

*Allium jesdianum* Boiss. et Buhse, in the wide sense. "Sorkhe, suroneh" (Persian)

This species name is also taxonomically under discussion. In this paper it is solely applied to Iranian populations. Plants from the type location (shady places among trees in the mountains of the Shir Kuh massif west of Yazd) show thin membranous bulb tunics, dull lanceolate leaves, a basally ribbed, dull green flower scape topped by a globular head of purplish-pink flowers (Fig. 8) with lanceolate-triangular tepals. Local people interviewed denied any use for these plants (Fritsch, 1996).

At the markets of Kermanshah province rather large amounts of fresh leaves of a medicinal plant named "sorkhe" we sold. These plants made the general impression as belonging to *A. jesdianum* but differed by shining (not dull) leaves, smooth (not basally ribbed) scapes, and thick and soft (not thin and membranous) bulb tunics. The sellers told us that the plants have come from "the mountains around". Later we were so lucky to find a few flowering plants in the wild on moderately steep and stony slopes



among large perennials (Fig. 9) which confirmed identical flower characters like *A. jesdianum*. The leaves also secreted a red liquid at the leaf bases and wounded parts from which the Persian names could be deduced (“sur” means “red”). These fresh leaves are used as general tonic and against rheumatism, as fresh salad, and mixed with yoghurt (Fritsch et al., 2006).

About 100 km more northward, in Kordestan province, we found very similar plants but with dull leaves and papery bulb tunics, which were growing in moist meadows and in ploughed fields. Flowers and inflorescences were again identical. The local people regarded these plants as weeds and denied any use.

In the Binalud mountain range not far from Mashhad in NE Iran we collected another variant of *A. jesdianum* showing noticeably lax and dull yellowish-green leaves, completely smooth scapes, and thin membranous bulb tunics. These plants were growing in the shadow of limestone rocks, near waterfalls, and along creeks. Local people again denied any use for these plants.

The described differences would be sufficient to recognize these morphologically and ecologically separable taxa as intraspecific entities. But currently it seems too early to describe them because investigations are still under progress to elucidate the areas of distribution, and also to search for transitional forms, which might exist among the different morphotypes.

*Allium rosenorum* R.M. Fritsch (*A. rosenbachianum* of Russian authors and of gardens, *A. jesdianum* of some authors) “Siekhalaf, siralaf, shipioz, jorji” (Tajikistan)

This much merged species is closely related to *A. jesdianum* differing by thicker and narrower leaves showing a more reflexed posture (Fig. 10), and a strongly ribbed scape also in fresh condition. The flower characters are similar to *A. jesdianum* and *A. rosenbachianum*. Thus herbarium specimens in anthesis but without well prepared leaves cannot be determined with certainty.

In the Vakhsh and Hissar mountain ranges of Tajikistan, young fresh or dried leaves are used for the national soup dishes ‘atolla’ and ‘oshi siralaf’ which are much esteemed for strong tonic properties (Keusgen et al., 2006). Kochkareva and Chukavina (1985) reported use as spice in that area, but the people interviewed by Keusgen et al. (2006) always denied any use as spice. Fresh leaves boiled in water did not present any spicy or otherwise remarkable taste characteristics (experiments made by R. M. F.).

Several years ago during taxonomic field-work in Tajikistan, R. M. F. was informed by local people that application of the fresh leaves of "siralaf" to wounds promotes quick healing. This experience was confirmed during a specific test: this species showed remarkable antibiotic activity against six gram-positive bacterial strains (Jedelská et al., 2005). The plants of this species also contain the afore-mentioned red dye, which is regarded as a 'sign of authenticity' when the leaves are collected in April and May. However, too intensive collection, if not plundering, has strongly diminished formerly rich populations in the mountains near Dushanbe, Tajikistan.

According to our information, dishes made from the leaves are explicitly consumed because of the tonic property. Contrary to the term 'motor' discussed above, the local names of this and the next species are not related to application.

*Allium rosenbachianum* Regel subsp. *rosenbachianum* and subsp. *kwakense* R.M. Fritsch "Gushi buzak" (Tajikistan)

This inconspicuous species grows in the shade under shrubs and trees and sometimes on moist terraces of north-facing steep limestone slopes in the eastern part of Central Tajikistan. The completely smooth and shining scapes are smaller than those of *A. rosenorum*, and the lanceolate and mostly shining leaves are still wider than those of *A. jesdianum*. Additionally, the yellowish-green and completely smooth leaves of *A. rosenbachianum* taper to a narrower base that is stalk-like in the typical subspecies and only somewhat narrowed in subsp. *kwakense* (Fig. 11). Both subspecies also differ in leaf posture. The flower characters are rather similar to *A. jesdianum* and *A. rosenorum*, but a specific characteristic of *A. rosenbachianum* is the inconspicuously silvery-pinkish flower color.

Fresh and dried young leaves are also used for the national soup dish 'latolla' which is much esteemed as an appetizer and general tonic in Central Tajikistan (Keusgen et al., 2006). The use of leaves as a condiment was also reported by Kochkareva and Chukavina (1985). The leaves of "gushi buzak" are equally estimated by the local population like "siralaf" leaves despite the fact that they do not contain red sap. In the mountains along Panj River in Tajikistan demand is already higher than supply, and the natural populations are strongly over-collected.

*Allium sarawschanicum* Regel

Although the inflorescences of this species (Fig. 12) are similar to those of *A. jesdianum*, flower color is more conspicuous, and the presence of six radial and upward directed outgrowths on the top of the ovary is most characteristic. Scapes and also leaves are similar to *A. rosenbachianum*, but the leaves of *A. sarawschanicum* differ by the triangular and not lanceolate, tapering tip. The distribution is restricted to Hissar and Zaravshan mountain ranges of Uzbekistan and Tajikistan, and to Kopetdag mountain range in Turkmenistan and Iran.

Medicinal use against skin diseases was reported only once in Uzbekistan (Sokolov, 1994). Currently, local people in Uzbekistan and Tajikistan deny any use of this species (Keusgen et al., 2004), and an error in identification seems possible.

*Allium stipitatum* Regel “Mu - sir” (Persian), “Pioz - anzur” (Tajikistan and Uzbekistan)

The taxonomic circumscription of this variable species is not yet clarified. Plants collected near the type location in Hissar mountain range of Tajikistan showed up to 8 cm wide leaves with a more or less dense indumentum of white hairs or at least teeth along the margins and at the veins of the lower side. Scapes are 80–120 cm high and smooth and shining; they become ribbed only when dry. The inflorescences are initially semi-globose and later depressed-globose bearing between 50–400 striking, star-like flowers having rose-pinkish to scarlet (rarely white or lilac) narrowly lanceolate tepals up to 12 mm long. The depressed-globose ovary is shortly stalked (thus the specific epithet) with an always rough (tuberculate) surface. Under cultivation, Iranian *A. hirtifolium* Boiss. plants (Fig. 13) were morphologically indistinguishable from *A. stipitatum*. Thus both names refer to one botanical species which occurs over wide parts of Central Asia to the Zagros mountain range of Iran. This species prefers loamy slopes and terraces with good soil, often in the shadow of shrubs and trees.

In several geographic regions (e.g. in western Tianshan, Khozratishoh, and Kopetdag mountain ranges), there are populations having a more slender stature, narrower and only slightly toothed or even smooth leaves, a smaller umbel, and more intensely-coloured tepals that in late anthesis are spirally enrolled. They are often separated as *Allium altissimum* Regel. Unfortunately the exact type location of this species is unknown, and the true identity could not be studied yet with modern taxonomic methods.



Tall *A. stipitatum* plants having more or less smooth broad leaves are often mis-named *Allium aflatunense* B. Fedtsch. However, the true latter species occurs only in the mountains surrounding the north-eastern edge of Fergan depression in Central Asia and is characterized by a generally stouter stature, lower scapes, a much denser umbel and broader tepals. *Allium aflatunense* of Dutch bulb trade is still another taxon (*A. hollandicum* R.M. Fritsch) characterized by a basally ribbed scape only 40-60 cm high in anthesis, narrower leaves, and broader but shorter tepals.

In Central Asia, sour pickling of the young bulbs as spice is the dominant use (Keusgen et al., 2006) and was also reported from Bakhtiar province of Iran (Fritsch, 1996). Medicinal application against skin diseases was only once mentioned (Sokolov, 1994), and medicinal use without further specification in Turkmenistan (Kurbanov, 2005, additionally under the name *A. altissimum*). In other provinces of Iran medicinal use is much more in focus. In Hamadan province fresh bulbs are sold at the markets to be used (possibly also after drying) against pains of backbone, legs, and feet (Fritsch et al., 2006). Somewhat surprising was the report of *A. stipitatum* as poisonous plant used as repellent for mice, rats, and cockroaches (Kurbanov, 2005).

It is a controversial item of discussion among the political authorities in Tajikistan and Uzbekistan as to whether intense collecting of the bulbs for making preserves has strongly diminished the natural populations. In some regions we have seen that it is a very common plant.

#### f) *Sect. Melanocrommyum* Webb et Berth. s. str.

This is the largest and at the same time most diverse section consisting of several subgroups differing by the length relations of leaves and scapes (leaves shorter or equal or longer than scape) and by inflorescence shape (fasciculate or umbellate or subglobose).

#### *Allium nigrum* L.

Most characteristic and the source of the species name are the ovaries which are blackish-green (in the Levante strongly red flushed) when in full anthesis but green when younger or after anthesis (Fig. 14). The lanceolate leaves are bent to the side and later reflexed. The smooth scape may become about 80 cm long and bears an umbellate and dense inflorescence with nearly star-like flowers. It is well known as an ornamental in European gardens and was introduced about a century ago.



Only a single record could be found about the medicinal use of this plant against carcinomas (see Dr. Duke's Phytochemical and Ethnobotanical Databases <http://www.ars-grin.gov/cgi-bin/duke/ethnobot.pl?ethnobot.taxon=Allium%20nigrum>)

g) Sect. *Miniprason* R.M.Fritsch

Only a single species belongs to this section.

*Allium karataviense* Regel “Chychka-kulak” (Uzbekistan)

This species was introduced in the European gardens about 120 years ago as a striking ornamental for rock gardens. The plants have 1-4 elliptic, rather wide, thick, bluish-green leaves and bear a rather dense flower head on a thick scape reaching scarcely more than 25 cm length in full sun. The star-like flowers show canaliculate, somewhat bent-up tepals of mostly rose-pinkish, sometimes deep pink to magenta color (Fig. 15). The natural area of distribution reaches from the Karatau mountain range of Kazakhstan to the Kugitang massif in eastern Turkmenistan and the Hindukush mountain range in Afghanistan.

In North Tajikistan, Uzbekistan, and probably other parts of Central Asia the plants are used against light diseases, pneumonia and lung problems (Sakhobiddinov, 1948, Sokolov, 1994, Khalmatov, 1964). Application promotes quick healing of wounds (Dadabaeva, 1972) but was not specified by other authors like Khassanov and Umarov (1989).

h) Sect. *Pseudoprason* (Wendelbo) K. Persson et Wendelbo

This section also contains only a single species.

*Allium koelzii* (Wendelbo) K. Persson et Wendelbo

This name refers to medium tall plants (Fig. 16) growing in West Iran in the central parts of the Zagros mountain range mostly in small populations. The ovate, yellowish-green and shining leaves may reach 10 cm width and more than 20 cm length. The straight, smooth scape is 60-80 cm long and bears a moderately dense flower head of milky-white, rather inconspicuous flowers. The ovate, concave tepals are only about 5 mm long and bear often three (sometimes up to 7) strip-like and narrowly parallel arranged mid-veins.

In Kermanshah province it was once reported that the bulb is cooked and used against skin diseases. This very specific use of the bulbs

may have been confused by the informant with that of *A. stipitatum* (Fritsch et al., 2006).

#### i) Sect. *Regeloprason* Wendelbo

Smooth scapes of moderate length and variable leaf characters are diagnostic for the 12 or so species of this section. Most characteristic are the narrowly campanulate to funnel-shaped flowers with a basal union of all tepals (for about  $\frac{1}{4}$  of the whole length) and filaments (up to half of the whole length).

#### *Allium hissaricum* Vved. "Sir" (Tajikistan)

Leathery bulb tunics, only one or two narrowly linear-lanceolate leaves, and an umbel-like inflorescence bearing lilac to pinkish-carmine, pleasantly smelling flowers are specific characters of this species (Fig. 17). It grows on grassy slopes of the Hissar, Gozimailik, and Vakhsh mountain ranges in Central Tajikistan. Fresh or dried leaves are applied against headache and fever (Keusgen et al., 2006).

### 3.2 Cysteine sulphoxide contents.

In the genus *Allium*, generally an onion or garlic-like taste and odour points to a high content of cysteine sulphoxides. Bulbs may contain more than 1% of these compounds relative to fresh weight, with amounts of 0.2-0.8% in different garlic accessions, and 0.2-0.3% in common onion (bulbs with a water contents of 60-80%; storage over several months increases content of cysteine sulphoxides). These amounts were regarded as very high and high, and species of subg. *Melanocrommyum* with medicinal use as mentioned in this publication sometimes contain high amounts of cysteine sulphoxides (Table 1). This was unexpected because other species most often showed only traces (below 0.1%) of these compounds, and rarely medium to low contents (Fritsch and Keusgen, 2006).

The different specific taste and odour is strongly influenced by the presence or absence of alliin, isoalliin, methiin, and propiin, and by the relations between these four main substances if two or more of them are present. They are stored in the cytoplasm. Decomposition of these sulphoxides into volatile, intensely smelling and tasting sulphur compounds (for more details see Keusgen, 2002) is caused by the enzyme alliinase, which is located in the vacuole. Therefore this process can only start after mechanical or thermal injury of the cells. The resulting compounds possess antimicrobial, antifun-

gal, and anticancer activities, lower lipid and blood glucose levels, and show different minor protective effects (Keusgen, 2002). Because the decomposition products of the different cysteine sulfoxides have similar medicinal properties; only the total contents are of interest (Table 1). This study is not complete yet, and therefore data for *A. costatovaginatum*, *A. nigrum*, and *A. koelzii* are still missing.

**TABLE 1.** Total contents of cysteine sulfoxides of different species, related to the fresh weight of bulbs (B) and dry weight of leaves (L). Each accession number was analysed four times.

| Name of the taxon         | total contents [%] (average) | Number of determinations | Origin of the accessions |
|---------------------------|------------------------------|--------------------------|--------------------------|
| <i>A. akaka</i> s. lat.   | B: 0.63                      | 1                        | Iran                     |
| <i>A. motor</i>           | B: 0.21 L: 0.07              | 1                        | Uzbekistan               |
| <i>A. severtzovioides</i> | B: 0.10                      | 1                        | Uzbekistan               |
| <i>A. suworowii</i>       | B: 0.68 L: 0.06              | 4                        | Tajikistan and IPK       |
| <i>A. chitraticum</i>     | B: 0.09 L: 0.94              | 1                        | Tajikistan               |
| <i>A. komarowii</i>       | B: 0.08 L: 0.81              | 2                        | Uzbekistan, Tajikistan   |
| <i>A. jesdianum</i>       | B: 0.36                      | 3                        | Iran and IPK             |
| <i>A. rosenorum</i>       | B: 0.03 L: 0.04              | 2                        | Tajikistan and IPK       |
| <i>A. rosenbachianum</i>  | B: 0.05 L: 0.08              | 1                        | Tajikistan               |
| <i>A. sarawschanicum</i>  | B: 0.03                      | 1                        | IPK                      |
| <i>A. stipitatum</i>      | B: 0.96                      | 1                        | IPK                      |
| <i>A. altissimum</i>      | B: 0.15                      | 1                        | IPK                      |
| <i>A. aflatumense</i>     | B: 0.63                      | 2                        | Uzbekistan and IPK       |
| <i>A. karataviense</i>    | L: 0.31                      | 1                        | Uzbekistan               |
| <i>A. hissaricum</i>      | B: 0.88 L: 0.05              | 1                        | Tajikistan               |

### 3.3 Presence of sulphur pyrroles.

The red stain present in several species mentioned above is chemically a sulphur pyrrole, a newly discovered natural substance (Jedelská et al., 2004). It was possible to isolate and to characterize this compound, which was only detectable in freshly wounded tissue, e.g. from *A. giganteum*. The chemical structure was determined as dithiodipyrrole (Fig. 18). It was assumed that the formation of the red dye is catalyzed by enzymes. An enzyme having catechol oxidase activity and consisting of two subunits with molecular weights of 24 kDa and 31 kDa could be isolated and partially purified (Vogt



et al., 2005). Incubation with a low-molecular weight extract of the same plant resulted in the formation of the red dye. The purified substance showed a strong antioxidative effect (see below), but its contribution to the health benefit of the entire plant was not clear until now.

During our fieldwork we became aware that this kind of red stain could only be observed in members of subg. *Melanocrommyum*, but not in all species. A few species did always show it (see above), other never did show it like *A. severtzovioides*, and still others showed variable color intensity, e.g. *A. karataviense*. Therefore this character was screened in the *Allium* reference collection in Gatersleben (IPK) in order to study the amount of variation and possible relations to taxonomy. This study is not finished yet, and preliminary results are given in Table 2.

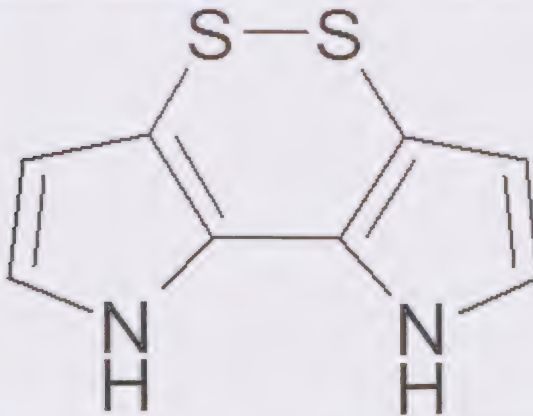


Fig. 18. Structure of the dithiodipyrrole isolated from *Allium giganteum*.



TABLE 2. Screening for presence of a red exudate in the *Allium* reference collection in Gatersleben (members of subg. *Melanocrommyum* only).

| Name of the taxon            | Color intensity* | Number of accessions screened | Origin of the accessions                                           |
|------------------------------|------------------|-------------------------------|--------------------------------------------------------------------|
| <i>A. akaka</i>              | 0                | 2                             | Iran                                                               |
| <i>A. motor</i>              | 2, 3             | 5, 3                          | Uzbekistan                                                         |
| <i>A. severtzovioides</i>    | 0                | 10                            | Uzbekistan, Tajikistan, Kazakhstan                                 |
| <i>A. costatovaginatatum</i> | 0                | 3                             | Uzbekistan                                                         |
| <i>A. suworowii</i>          | 0                | 6                             | Tajikistan, Kazakhstan, Uzbekistan                                 |
| <i>A. chitralicum</i>        | 0                | 1                             | Tajikistan                                                         |
| <i>A. komarowii</i>          | 3                | 6                             | Tajikistan, Uzbekistan                                             |
| <i>A. jesdianum</i>          | 3                | 13                            | Iran, Uzbekistan, Tajikistan, botanical gardens                    |
| <i>A. rosenorum</i>          | 2, 3             | 1, 25                         | Tajikistan                                                         |
| <i>A. rosenbachianum</i>     | 0, 1             | 4, 1                          | Tajikistan                                                         |
| <i>A. sarawschanicum</i>     | 0                | 13                            | Iran, Uzbekistan, Tajikistan                                       |
| <i>A. stipitatum</i>         | 0                | 36                            | Iran, Tajikistan, Uzbekistan, Kirgizstan, Kazakhstan, bot. gardens |
| <i>A. altissimum</i>         | 0                | 1                             | Kazakhstan                                                         |
| <i>A. aflatunense</i>        | 0                | 13                            | Tajikistan, Uzbekistan, Kirgizstan, Kazakhstan,                    |
| <i>A. nigrum</i>             | 0, 1             | 1, 1                          | Turkey, botanical garden                                           |
| <i>A. karataviense</i>       | 0, 1, 2, 3       | 10, 3, 1, 2                   | Tajikistan, botanical garden, Uzbekistan, Kirgizstan, Kazakhstan   |
| <i>A. hissaricum</i>         | 0                | 2                             | Tajikistan                                                         |

\* 0 = colorless, 1 = slightly reddish, 2 = red, 3 = dark red sap

### 3.4 Radical scavenger activity.

In humans, free radicals like oxygen radicals can induce several diseases, such as vascular diseases and cancer. These free radicals can be trapped by different natural compounds, mostly types of polyphenols. The potential to trap free radicals is described by the “radical scavenger activity”, which can

be investigated for pure compounds or extracts. For these tests, butylated hydroxytoluene (BHT) was used as reference compound (radical scavenger activity of 100%). It can be assumed that plant materials exhibiting a high radical scavenger activity are potential medicinal plants. Daily intake may prevent cardiovascular diseases and cancer. Radical scavenger activities larger than 40% are significant. Radical scavenger activity of dithiodipyrrole (see above) was found to be approximately 100%, meaning that this compound is a very strong radical scavenger.

Currently results for 39 wild *Allium* species and garlic (Jedelská et al., 2004, and unpublished data) are available which showed a significant activity for 24 species and garlic. Ten of eleven species, which showed even a higher activity than the reference compound, belong to subg. *Melanocrommyum*, and eight of the latter ones developed red sap when wounded. However, no correlation to cysteine sulfoxide contents was found in this material.

TABLE 3. Radical scavenger activity of members of subg. *Melanocrommyum* (Jedelská et al., 2004, and unpublished results).

| Name of the taxon        | relative activity* [%] | Number of determinations | Origin of the accessions |
|--------------------------|------------------------|--------------------------|--------------------------|
| <i>A. motor</i>          | 110                    | 1                        | Uzbekistan               |
| <i>A. suworowii</i>      | 4                      | 1                        | Uzbekistan               |
| <i>A. komarowii</i>      | 110, 116               | 2                        | Uzbekistan, Tajikistan   |
| <i>A. jesdianum</i>      | 109, 109, 113          | 3                        | Iran, IPK                |
| <i>A. rosenorum</i>      | 109, 123               | 2                        | Tajikistan               |
| <i>A. rosenbachianum</i> | 34                     | 1                        | Tajikistan               |
| <i>A. stipitatum</i>     | 16, 16                 | 2                        | Tajikistan               |
| <i>A. aflatunense</i>    | 17                     | 1                        | IPK                      |
| <i>A. karataviense</i>   | 53                     | 1                        | Uzbekistan               |
| <i>A. hissaricum</i>     | 45                     | 1                        | Tajikistan               |

butylated hydroxytoluene (BHT) = 100%; garlic 45 ... 84%.

#### 4. DISCUSSION

First we would like to explain that nearly all of the data presented originated from people who were neither qualified physicians nor well trained local healers. We strongly warn against basing any healing aims or self medications on this information. We intensely tried to present all data as exactly as possible but cannot guarantee for exactness in the sense of law.

The majority of the medicinally applied species mentioned above contain more cysteine sulphoxides in the bulbs than common onion, and several even more than garlic. Therefore, these compounds may well represent the main medicinally active principle in species like *A. suworowii* and *A. stipitatum*, the bulbs of which are only applied externally. Unexpectedly, in *A. chitralicum* and *A. komarowii*, we detected remarkable high contents in the leaves but only traces in the bulbs. Also in these cases the high cysteine sulphoxide contents in the leaves could be important. Most other species showed a much lower cysteine sulphoxide in the leaves compared to the bulbs (Table 1). Unfortunately, we cannot discuss these relations in detail. Many species possess only remains of leaves in the flowering stage, and during our field-work we were not able to collect dried leaves of all species dealt with in this paper. On the other hand, only leaves from *A. karataviense* could be analysed, because the bulb was in bad condition during harvesting time.

High medicinal activity and very high radical scavenger activity (Table 3) of another group of species (*A. motor*, *A. komarowii*, *A. jesdianum*, *A. rosenorum*, and possibly also *A. karataviense*) is clearly related to the presence of sulphur pyrroles (see Table 2). These species are highly valued for their medicinal and tonic properties. We must therefore conclude that sulphur pyrroles are powerful pharmaceutical agents.

Finally, we should not overlook the fact that *A. severtzovioides* and *A. rosenbachianum* did not contain significant amounts of cysteine sulphoxides and showed no or only slight sulphur pyrrol activity, but they are still regarded as medicinal species. *Allium rosenbachianum* showed also rather low scavenger activity (Table 3, *A. severtzovioides* was not tested yet). Therefore we must conclude that further substances contribute to the proposed medicinal effects of these species, e.g. saponins, polyphenols, and sugars.



*Allium akaka*, *A. nigrum*, and *A. koelzii* became known to us as medicinal plants only very recently, and chemical data are not yet available for discussion. The inclusion of *A. sarawschanicum* was most probably caused by a mis-identification.

Certainly more species than detailed described and discussed above could be prospective medicinal plants and nutraceuticals. First choice in this respect would be several species showing high (> 100 %: *A. alaicum* Vved., *A. chelotum* Wendelbo, *A. giganteum* Regel, *A. macleanii* Bak., *A. winklerianum* Regel) or at least significant radical scavenger activity (> 40 %: *A. huchanicum* Regel, *A. cristophii* Trautv., *A. ellisii* Bak. (Jedelská et al., 2004, and unpublished data). However, some of them are rare species which could only gain importance as medicinal plants when taken under cultivation. Other ones like *A. giganteum* and *A. macleanii* are eaten as vegetables by the local population in Tajikistan and Iran. Probably the specific knowledge of their health-supporting and medicinal impact was lost in the past. Sokolov (1994) mentioned also *A. decipiens* Schult. et Schult. f. and *A. fetisowii* Regel to possess a medicinal potential because of bactericidal and fungicidal activity.

#### ACKNOWLEDGEMENTS

The authors are greatly indebted to organizers and local scientists supporting the field-work in Iran, Tajikistan and Uzbekistan, especially to Dr. Mehrdad Abbasi, Prof. Dr. Hikmat Hisoriev, and Dr. Furkat Khassanov. Funding by VolkswagenStiftung (Hannover, Germany) under the general funding theme "Zwischen Europa und Orient-Mittelasien/Kaukasus im Fokus der Wissenschaft" is gratefully acknowledged.

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**NAMAQUANULA BRUYNsii IN ITS HABITAT ON THE TIRAS  
MOUNTAINS OF SOUTH-WESTERN NAMIBIA, WITH AN ACCOUNT  
OF CULTIVATING AND PROPAGATING THIS SPECIES**

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*Photography by Connall Oosterbroek*

**FIELD ACCOUNT**

The Tiras Mountains in south-western Namibia and the Rooirand to the east are home to a number of dwarf bulbous plants. These only emerge after good late summer and autumn rains, and several dry years may pass in succession without these bulbs emerging from dormancy.

*Namaquanula bruynsii* is currently known from the highest sections of the Tiras Mountains occurring at an altitude of about 1900 m. These mountains are remote and rugged. Further exploration may indicate that the bulbs occur more widely than on the west central part of the range.

The mountain summit region consists of an uneven plateau with numerous boulder outcrops and rocky ridges. The latter are interspersed with some flat or gently sloping terrain. The plateau is drained by large streams with deep sandy beds lined by camel thorn trees, *Acacia erioloba*. These streams flow briefly after occasional good rainfall.

A small portion of locale on the plateau contains shallow washes with an almost imperceptible gradient, and this is the habitat of *Namaquanula bruynsii*. Water flows briefly in these washes after rainfall, and then the washes become seepage areas for short periods. The gradient in this habitat is so slight that this niche is stable and not subject to water erosion after heavy rainfall.

The bulbs grow singly or in small scattered groups of 3 to 6 bulbs, with rarely more individuals in a group. Most of the large colonies contain bulbs of different ages ranging from seedlings to large, well-established adult bulbs. Some of them grow beside woody-evergreen, low growing shrubs or in deep soil pockets between large stones. Bulbs are usually found at the fringes of the washes, and seeds are likely to have been distributed there via runoff after rainfall.

Bulbs occur deep in the soil, usually at least 12-15 cm below the surface. The bulb plates often rest on buried sheets of exposed rock. The latter is the

slowest draining part of the microhabitat after good rainfall.

The summit of the plateau where the plants were studied is well grazed by cattle. The livestock keep the washes and surrounding areas free from dense accumulations of short grass tufts which are frequent all over the mountain summit.

*Namaquanula bruysii* and species of the Genus *Lachenalia* and the Genus *Ornithogalum* respond to rainfall from mid-summer to early autumn. There seems to be a critical minimum of precipitation required to trigger flowering in the case of *N. bruysii* and leaf production amongst the other dwarf bulbs. These conditions occur rather infrequently, and *N. bruysii* bulbs probably spend a good deal of their lives in extended dormancy. Should sufficient rain fail to trigger flowering and leaf growth, the bulbs retain their foliage throughout the winter. The leaves die back in late August and September at a time when temperatures usually begin to increase sharply.

*Namaquanula bruysii* is similar in its growth cycle and habits to several plants in different genera from the summer rainfall interior of South African. The latter, such as *Daubenya comata*, respond only to late summer and early autumn rains, flowering between March and June. Leaves start to wither during August.



Fig. 1. A *Namaquanula bruysii* bulb with leaves about 2.5 cm tall, about 12 days after initial exposure to rainfall on 19 December.



Fig. 2. *Namaquanula brunsii* flower buds fully formed and ready to open 12 days after the bulb was first exposed to rainfall.





Fig. 3. *Namaquanula bruysii* scapes usually emerge before the leaves, but on occasions leaves and scapes arise simultaneously.



Fig. 4. *Namaquanula bruynsii* starting to flower on 7 January after the bulbs had been exposed to several rain showers beginning 19 December. Flowers opened mostly between 0900 and 1000 am. All flowers on an umbel usually open within 6 days from the opening of the first flower.

A thorough search was conducted on the summit of the northern section of the Rooirand immediately east of the Tiras Mountains in late May 2000. The habitat was similar to that on the summit of the Tiras Mountains but found at a slightly lower altitude, about 1700 metres. Most of the small bulbs that were present on the summit of the Tiras Mountains, particularly *Lachenalia* and *Ornithogalum*, were also found there in almost identical habitats. However, no *N. bruynsii* were found. The summit plateau of the Rooirand was much narrower than equivalent terrain on the Tiras Mountains, and it also lacked the low gradient sandy washes. The latter may have explained the absence of *N. bruynsii* from the northern section of the Rooirand.

*Namaquanula bruynsii* is very well adapted to survive in an arid environment that experiences prolonged dry periods. The bulbs are encased in masses of old fragile bulb tunics. This phenomenon develops very early in the life of the bulb, from the second growth season after the seedlings have established. It is shared only by *Namaquanula bruce-bayeri* in the Hessea



Fig. 5. Details of *Namaquanula bruysii* flowers.

and *Strumaria* group, a species that also frequents very arid habitats subject to frequent and prolonged droughts. Layers of compacted bulb tunics like those in *N. bruysii* are regularly encountered in most *Brunsvigia* species.

#### CULTIVATION

*Namaquanula bruysii* is cultivated in red Magaliesberg quartzite soil in Johannesburg, and it is grown in large terracotta pots resembling the conditions in their natural habitat. Quartzite grit is sparsely scattered across the surface of the soil.

Bulbs are grown in locations which only receive either morning or afternoon sunlight. During dormancy from early September until late December, they are kept in a well ventilated, hot sunny position and given no water. Bulbs are taken out of dormancy in late December and watered via exposure to rainfall. These cultivation conditions approximate the habitat found on the Tiras Mountains.

The flowering, seeding and leafing habits of the bulbs in cultivation are likely to have many similarities to bulbs in nature. The details of the 2006 flowering season are discussed below.





**Fig. 6a (Top), 6b (Left), and 6c (Bottom).**  
*Namaquanula bruynsii* photographed on 16 August. Leaves are typical of the period a few weeks before the bulbs enter dormancy with noticeable withering of the foliage from the leaf



### FLOWERING OF NAMAQUANULA BRUYNsii IN JOHANNESBURG

Bulbs were taken out of dormancy on 19 December. They had gone dormant the previous August. Pots containing the bulbs were placed in strong direct sunlight out in the open and exposed to rainfall. Regular summer storms occurred most afternoons from 19-30 December.

Three bulbs produced flower buds 3-4 days after exposure to rainfall, and all 10 bulbs that flowered produced buds within 12 days after the initial exposure to rainwater.

Buds started to open and reveal individual flowers on the umbels from 14 days after bulbs were first exposed to rainfall. Flowering occurred on different umbels from 6-12 January.

Seed development was very rapid, and all seeds on the different umbels were fully mature by 28 January. Seeds were harvested, and the first few began to produce a root within 3 days after they were collected. The remainder, except for 4 out of 69, had roots within a week, and some quickly developed their first 1-2 young leaves. Seeds were stored on a flat-open plastic tray which was kept on a shelf in shade. Roots and leaves had all started to develop before planting.

The inflorescences with ripe seeds detached from the bulbs and were easily blown about in the wind. These ripe seeds were very heavy for the dry inflorescences. Some dropped off before the inflorescences detached from the bulbs.

The seeds were very large for a *Hessea* type plant. Most seeds were  $\frac{1}{2}$  cm long, indicating that they contained enough reserves to sprout and root with scant rainfall.

Leaves emerged at the time buds and flowers were formed in the case of plants that flowered. With respect to the non-flowering bulbs, most leaves emerged soon after exposure to rainfall, with only a few remaining dormant till about 5 weeks after they first received rainwater.

### PROPAGATION

*Namaquanula bruynsii* is grown in Johannesburg in terracotta pots 20 cm deep and 25 cm wide that are filled in red-loamy, gritty quartzite soil collected from the Magaliesberg. This is almost identical to the conditions in habitat. Pots are exposed to rainfall from late December until the end of the rainy season. Thereafter pots are moved into the greenhouse, where the bulbs are deeply watered occasionally during the winter. The leaves wither in late August once the temperatures warm up, but bulbs are fully evergreen

from late December to late August.

Well-rooted seeds are sown in sieved Magaliesberg-red-quartzitic loam and kept moist throughout the growing period. Individual seeds are sown 2-3 cm apart in the same type of containers in which the mature bulbs are cultivated.

The young bulblets had well developed leaves by the end of April and these continued to grow throughout the winter. In all characteristics, the young bulblets resembled mature bulbs. Leaves had the characteristic of dying back from their apices by May, and bulbs had developed their first protective tunics by late July. Foliage started to wither in the first half of August, and some bulbs were fully dormant by 20 August.

#### THE STATUS OF *NAMAQUANULA BRUYSII*

The autecology of *N. bruysii* is virtually identical to that of dwarf *Brunsvigia* species from the Northern Cape in South Africa.

The bulb structure of *N. bruysii*, particularly the masses of tightly packed, brittle bulb tunics, is the same in a new undescribed *Brunsvigia* species from the Pellaberg and surrounding area. This bulb tunic feature is also shared by *Brunsvigia namaquana* from the arid regions of the eastern Khamiesberg. The latter species grows in very similar habitat to *N. bruysii*.

The large rounded seeds of *N. bruysii* are roughly the same size as those of the Pellaberg *Brunsvigia*. The dried inflorescences of both species detach from the neck of the bulb in the same manner, liberating seeds as they are blown about in the wind.

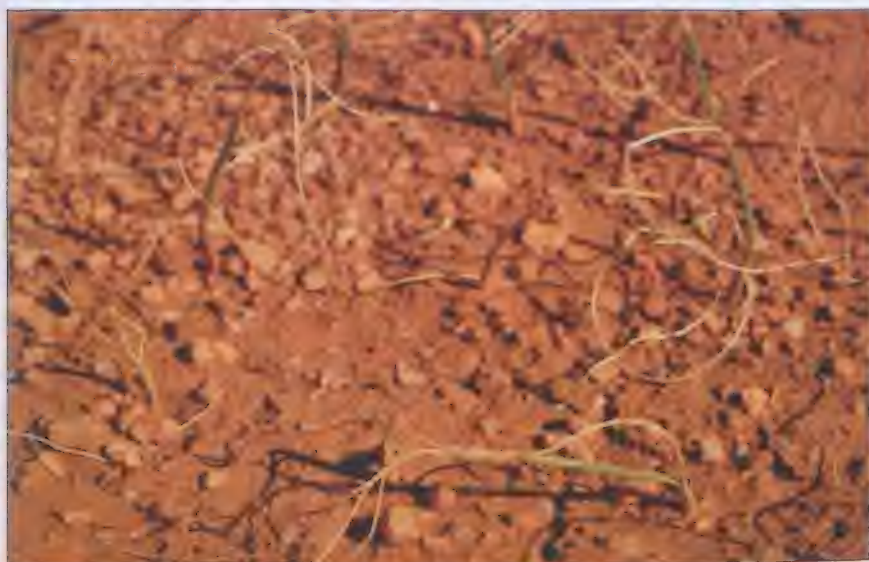
January is the typical flowering month of the dwarf *Brunsvigia*. It may be no coincidence that *N. bruysii* flowers at the same time.

It may be useful in due course to reassess the taxonomic placement of *N. bruysii*, taking into account its physical characters in conjunction with its autecology. It is possible that *N. bruysii* may be more realistically accommodated in the Genus *Brunsvigia*.

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**Fig. 7a. (Top) and Fig. 7b (Bottom)** Juvenile *Namaquanula bruysii* photographed on 16 August at the time the first bulbs started to enter dormancy. The seeds from which these bulbs developed were sown in late January. The immature bulbs resembled the adults in most respects with leaves well withered from the apices and with development of the initial bulb tunics

*CRINUM FIMBRIATULUM* BAKER

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## INTRODUCTION AND SOURCE OF MATERIALS

The type specimen for *Crinum fimbriatulum* Baker (Welwitsch 4018, K) was collected by the Austrian physician and botanist Freidrich Welwitsch in Angola. Welwitsch served in the employment of the Portuguese Government, and he was sent to Angola from 1851 to 1863, where his mission was to study the flora and fauna. He collected over 5,000 botanical specimens during his stay. Although Welwitsch died in 1872, the specific identification of *C. fimbriatulum* was not published by Baker until 1878. The collection locality was specified as the Province of Loanda (Luanda), in meadows inundated during summer, and at elevations less than 1000 ft. Baker thought that this species closely resembled *C. broussonetii* (Redoute) Herbert, and the identification card on the type specimen actually shows where Baker had inscribed *C. broussonetii* as the initial identity, but later he crossed this out and wrote *C. fimbriatulum*. The type specimen consisted of a long tapering leaf and one flower including perianth tube and ovary.

Other than repetition of Baker's description, botanical literature was silent about this species until Hannibal (1970) published a photograph identified by Gordon McNeil as *C. fimbriatulum*. McNeil, of Ofcolaco, Transvaal, South Africa, was an IBS member, and he had traveled in Angola where he collected this species. The photograph represented a bulb in flower that McNeil had grown in cultivation. McNeil was best known for his work with *Clivia* and his association with the Blackbeard *Clivia* Collection; he died in 1986.

During my first visit to South Africa in 1987, I visited McNeil's widow at Ofcolaco to inquire about the disposition of his plant collection (Lehmillier 1987). Although I did not recognize it as such at the time, one of McNeil's *Crinum* was in bloom which I happened to photograph (Fig. 1), and upon my return, I compared it to McNeil's photo in Hannibal's publication and discovered that it was McNeil's *C. fimbriatulum*. When I returned to South Africa in 1988, I again visited Mrs. McNeil, and she kindly gave me a bulb that was marked with Gordon McNeil's label designating it as *C. fimbriatulum*.



Fig. 1. *Crinum fimbriatum* Baker in bloom at the estate of Gordon McNeil, Ofcolaco, Transvaal, South Africa, January 24, 1987. All photographs by the author.





Fig. 2. *Crinum fimbriatulum* Baker in bloom, from Leach 14510, cultivated in Southeast Texas.



Fig. 3. *Crinum fimbriatum* Baker in bloom, cultivated in Southeast Texas.

During my visits to South Africa, I developed a close relationship with Dave Hardy (now deceased), senior horticulturist at the National Botanical Institute (NBI) in Pretoria, and we collected in the field in Southern Africa and Madagascar on seven occasions. During one of my visits to NBI, I discovered that McNeil had deposited one of his photographs of *C. fimbriatum* in the herbarium photographic files. I also noticed a bulb in the nursery, Leach 14510 (PRE), which had been collected in Angola near Ruacana by the Cunene River and had been labeled as *C. kirkii* Baker; this bulb I recognized as identical to the *C. fimbriatum* collected by McNeil. Hardy obtained seed from the Leach bulb and sent them to me. I cultivated the latter in the ground alongside McNeil's bulb, and indeed they proved to be the same species. These bulbs grew robustly in the warm moist climate of Southeast Texas, and they became large plants and multiplied via offsets as well as by self-seeding (Fig. 2, 3).

During two field trips, Hardy and I attempted to find this species along the Namibian side of the Cunene River near Ruacana, but we were not successful (Lehmiller, 1997). Presumably the Leach specimen collected in Angola by the Cunene River represented a solitary specimen that had washed down river from Central Angola and lodged in the rocks near Ruacana.

## DISCUSSION

*Crinum fimbriatulum* is a unique species and differs from *C. broussonetii* by multiple characters, including: fruit with a long rostellum (Fig. 4) versus no rostellum in *C. broussonetii*, large bulky seeds (Fig. 5) with a pithy consistency versus small smooth seeds stacked in columns in *C. broussonetii*, and light tan anthers versus black anthers in *C. broussonetii*. Minor character differences include longer scapes, larger umbels, and longer leaves in *C. fimbriatulum*. DNA sequence studies separate these two species (Meerow et al, 2003), and this analysis suggests that the two species are not closely related.

*Crinum kirkii* is an East African species; its morphology differs significantly from *C. fimbriatulum* by possessing unique leaves with crispate margins, erect spathe which envelope the perianth tubes at anthesis, large red fruit lacking a rostellum, and smooth ovoid seeds. These two species are not closely related by DNA sequence studies (Meerow et al, 2003).

The description of *C. fimbriatulum* provided by Baker was limited, since he never observed a living bulb. Baker did utilize selected data provided in Welwitsch's field notes (see Rendle, 1899), but he neglected some of the field data; i.e., Welwitsch listed the length of the leaves as 2-5 feet long and described them as roundly grooved, long, and acuminate, whereas Baker only specified 2-3 feet long leaves which tapered to a point. A more detailed description from living plants cultivated under optimal conditions follows:

### *Crinum fimbriatulum* Baker.

J. Bot. London, p. 196, 1878.

Type: Angola. Province of Loanda (Luanda), Welwitsch 4018 (Holotype, K).

### Description:

Bulb ovoid, covered with layers of brown papery scales, 70-160 mm in diameter, with an above-ground false stem 70-150 mm long; basal offsets produced. Leaves 12-16, forming a rosette, suberect and arching, widest adjacent to the base, deeply channeled but lacking a depressed midrib, long and tapering to a slender point, containing tiny wooly fibers when torn apart; margins finely serrated; green, usually with intact apices excepting old leaves, 900-1450 mm long, and up to 75 mm wide. Scape appearing after the leaves have formed, long and stout, light green, 1070-1400 mm long. Spathe valves spreading at anthesis, 115-135 mm long by 55-65 mm wide. Umbel (3)-10-21 flowered; flowers zygomorphic, bell shaped, sessile, pleas-



antly scented. Buds initially erect, then migrating outward and inclining about 30 degrees below horizontal, then arising to horizontal or slightly above horizontal at anthesis. Perianth tube curved only in the distal 20-30 mm portion at anthesis, and at one day post-anthesis, the flower droops with only the distal tube curved; light green, 120-150 mm long. Flowers nocturnally opening. Segments white, with a ventral dark-pink stripe that does not extend to the seg-



Fig. 4. Fruit of *Crinum fimbriatum* Baker, cultivated in Southeast Texas.

ment tip, with a less prominent dorsal stripe, unequal with the inner broader and shorter, near lanceolate, 114-133 mm long by 27-38 mm wide; distal tips recurved at anthesis, with small apiculates. Filaments white, unequal with the inner longer, declinate, 80-95 mm long; anthers initially gray-white, turning light tan at maturity and becoming U-shaped; pollen light tan. Style white becoming light pink distally, 93-105 mm long; small capitate stigma. Fruit bulky and somewhat globular, with an apical rostellum 50-115 mm long, light green, turning dull yellowish at maturity, indehiscent, 40-60 mm in diameter; seeds 1-6 per fruit, large and bulky with a pithy texture, usually with branching small crevices in the outer surface, pale light green, 20-50 mm in diameter.

Habitat: In meadows flooded during the summertime.

#### ACKNOWLEDGEMENT

Botanical illustrator and IBS Member, Kristin Jakob of Valley Mills, California, is gratefully acknowledged for the botanical illustration of *Crinum fimbriatulum* Baker exhibited at the conclusion of this manuscript (Fig. 6). The latter represents the only known illustration of *C. fimbriatulum* currently in existence.

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Fig. 5. Seed of *Crinum fimbriatulum* Baker, cultivated in Southeast Texas.



Fig. 6. Illustration of *Crinum fimbriatulum* Baker by Kristin Jakob.



(POST-DATED) ADDENDUM NOTE: *CRINUM FIMBRIATULUM*  
BAKER

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*Photography by Wolfram Lobin*

FIELD ACCOUNT

Dr. Wolfram Lobin recently contacted me concerning the identity of a *Crinum* species that he had encountered while collecting in Angola. From his beautiful field photographs, there was no mistaking that the species he saw was *Crinum fimbriatulum* Baker. He observed and photographed this species in Parque Nacional de Quicama (Quissama) south of Luanda at altitude 160 m, which possibly would be near the locality where Welwitsch originally collected this species. He also recalled seeing this species west of Luanda from his car.

His account augments the scant habitat details provided by Baker. The bulbs were growing in periodic flooded depressions in Dry-Forest-Communities where tree-layered *Adansonia digitata* and *Euphorbia conspicua* were rather common. His remarkable photographs indicate that the bulbs grew in full sun.

Several differences are apparent between field bulbs and the cultivated bulbs described in the preceding article, presumably due to cultivation artifacts:

- 1) Scapes appear during early leaf development in the field, whereas leaves are well developed when flowering occurs in cultivation.
- 2) Leaves of field bulbs display prominent undulations in many instances (Fig. 3), whereas this feature is not present in cultivated bulbs. (Leaf undulations in cultivated bulbs of many *Crinum* species frequently disappear or are greatly diminished, likely a result of abundant moisture available during cultivation.)
- 3) Field bulbs (Fig. 4) do not exhibit above-ground false stems as do the cultivated bulbs.
- 4) The reddish pigment in the petals is stronger or more vivid in the field bulbs. Reddish-brown pigment also is sometimes strongly evident in the scapes of the field bulbs, whereas the scapes are entirely green in cultivation.



Fig. 1. *Crinum fimbriatum* Baker in habitat south of Luanda, Angola.



Fig. 2. *Crinum fimbriatum* Baker in habitat south of Luanda, Angola.



Fig. 3. *Grinum fimbriatulum* Baker. Note the leaf undulations of the bulb in the lower right hand corner.



Fig. 4. *Grinum fimbriatulum* Baker. Note the lack of an above-ground false stem in the bulb in the background.





Fig. 5. Flowering umbel of *Crinum fimbriatum* Baker.



Fig. 6. Flower close-up of *Crinum fimbriatum* Baker.

Dr. Lobin has kindly offered to share his photographs to accompany the preceding article, and a sampling (Fig. 1-6) has been selected. Dr. Lobin's botanical explorations in Angola have been carried out through a project of CARITAS-Angola. His position is:

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D-53115 Bonn, Germany  
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Homepage: [www.botgart.uni-bonn.de](http://www.botgart.uni-bonn.de)

**LEDEBOURIA SPECIES AFFINIS *LEDEBOURIA MONOPHYLLA*  
(HYACINTHACEA) IN HABITAT EAST OF ROOSSENKAL  
MPUMALANGA, SOUTH AFRICA**

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*Photography by Connall Oosterbroek*

**INTRODUCTION**

Stephanus Venter (1993) originally describes *Ledebouria monophylla* in his Masters of Science Thesis from collections at Paradise Camp on the Mpumalanga escarpment north of Graskop. However, the name *L. monophylla* is also used in his Thesis for other collections of *Ledebouria* species from various parts of the Mpumalanga escarpment characterized mostly by "one leaf *closely pressed to the ground.*" *It may be that these latter plants, apart from the type collection, are something else. In this sense the presentation and discussion that follows refers to the plants as "sp. aff. *Ledebouria monophylla.*"* The autecological research must be published under some name, and "sp. aff. *L. monophylla*" is the one that seems to describe the plants best when there is presently nothing else published.

This bulb is quite distinctive and unlike any other *Ledebouria* species. Sp. aff. *Ledebouria monophylla* is found mostly in mist-belt mountainous grassland in Mpumalanga. At Mount Sheba in the Pilgrims Rest area, it occurs in grassland as well as under scrubby mountainous vegetation. Elsewhere the bulbs are found mostly in short grassland nearly always in moist habitats such as around seepages, in marshy areas, near streams and also in thick water-retentive swards of soil. These places with deep soil are usually at the sides of sheets of exposed rock which funnel off the water after rainfall. The bulbs also grow in deep pockets of soil on steep hillsides in locations experiencing frequent summer mists and rainfall. A study has been conducted concerning the autecology of bulbs growing on the Steenkampsberg, and the results are discussed below.

**SP. AFF *LEDEBOURIA MONOPHYLLA* ON THE STEENKAMPSBERG**

The Steenkampsberg is an isolated mountain east of Roosenekal in Mpumalanga. The southern parts of the mountain are mostly at an altitude of around 1800-2300 m, most of which lies in a mist belt. Sp. aff.





**Fig. 1.** Sp. aff. *Ledebouria monophylla* growing in newly created habitat beside a road over the Steenkampsberg. A large cutting, facing southeast, has been extensively colonized where there are artificially created seepage areas. Shattered rock fragments from the road construction process are visible amongst the plants.



**Fig. 2.** Sp. aff. *Ledebouria monophylla* often grows in deep pockets of soil amongst rocks on the Steenkampsberg in south-facing positions. These water retentive localities are often moist for week on end during the summer.

*Ledebouria monophylla* is restricted mainly to this mist belt growing on east, southeast, west, and southwest facing slopes.

The bulbs occupy water retentive habitats on the east and southeast facing slopes of the mountain. The more arid west and southwest facing slopes have fewer moist areas, and here the bulbs are confined to short marshy grassland beside large seepage areas or streams. The habitat has been artificially extended by water retentive depressions in a road reserve on the western summit of the mountain.

#### BULBS ON THE WESTERN AND SOUTHWESTERN SLOPES

Sp. aff. *Ledebouria monophylla* is locally plentiful on the western side of the Steenkampsberg where it is apparently entirely confined to the mist belt. The habitat is very restricted, consisting of moist grassland which is permanently damp for the duration of the summer and autumn. This habitat, found within 2-12 m from streams and in the immediate vicinity of seepage areas, is usually crowded with bulbs. They grow in close proximity to one another between tufts of grass as well as in the grass tufts themselves. The small size of mature bulbs allows them to occupy nearly all the niches in this limited area.

Bulb populations undergo fluctuations in numbers as a result of trampling by livestock, mostly cattle and sheep. The trampling often occurs during the flowering time in October and early November. The first green grass of the summer growing season is usually found around seepage areas and streams. In these places it is moist enough for the grass to start growing before the first rains which usually fall at the end of October and in early November. Once the rains begin, the livestock start to graze in the surrounding grasslands which do not form part of the *Ledebouria* habitat.

In places where grazing is heavy, much of the sp. aff. *L. monophylla* habitat can be destroyed by the hooves of grazing animals. However, grazing is very variable, and the flatter areas are most at risk from trampling.

Bulbs growing in artificial habitat in the road reserve are not grazed and may become very abundant. They quite often serve as reservoirs which produce seeds to repopulate adjacent areas of grazed farmland.

#### BULBS ON THE EAST AND SOUTHEAST SLOPES

Sp. aff. *Ledebouria monophylla* is more plentiful on the east and southeast slopes of the Steenkampsberg. There is a greater range of moisture retentive places here, and the slopes are free from the desiccating rays of the afternoon sun.



Fig. 3. Sp. aff. *Ledebouria monophylla* is usually in full flower shortly after the leaves begin to emerge. This photograph was taken on 24 October on the eastern slopes of the Steenkampsberg.



The bulbs are found around seepage areas, in damp soil on rocky hill-sides, and on broad ledges of broken cliffs with deep, seasonally moist pockets of soil. A densely utilised habitat consists of seepage areas and their surroundings on a broad road cutting. This area is fenced off from the surrounding farmland and is not subjected to grazing pressures from domestic stock.

Groups of bulbs, though more frequent than those in the limited niches on the west slopes, are usually smaller. The reason is that the grass and herb cover is thick with fewer open places for sp. aff. *L. monophylla* to colonise. The bulbs are absent from much damp-stream-side habitat as the shrub and grass cover is too dense. Bulbs are better protected here from grazing livestock than they are on the western slopes, since they do not usually occur around streams. The boggy stream-side habitat is readily damaged by the hooves of grazing animals. Goats are not currently kept on the Steenkampsberg in the study area. If they are introduced, their grazing habits are likely to degrade the mountainside since they clamber into rocky and steep areas not usually frequented by cattle and sheep.

### THE GROWTH CYCLE

Sp. aff. *Ledebouria monophylla* flowers in the spring usually during the last two weeks of October and the first week of November. Bulbs are normally in bud and sometimes also in flower at the time the leaves start to emerge. They initiate bud and leaf development before the summer rains begin, but this process is accelerated if the mountain is subjected to misty conditions in the early spring.

Leaves are fully developed by the time the bulbs have finished flowering and have started to form seeds. Seeds are liberated into the environment in late November and early December. They usually germinate around the parent bulbs, but seeds may be distributed some distance by water runoff after rain showers. Seeds germinate quickly if they ripen at the same time as the occurrence of regular rainfall. Those that land in moist places, usually around seepage areas, do not require rainfall in order to germinate.

This species, like most *Ledebouria* which grow in grassland, is dependent on periodic winter grass fires to clear the habitat of moribund vegetation. In the inter-fire years, flowering is restricted mostly to bulbs growing in open habitat. Bulbs grow well after fires, which is also the time when conditions for seed germination are optimum.

Bulbs enter dormancy in early May at a time when the habitat is drying



Fig. 4. *Ledebouria saundersonii* in full flower high up on the summit of the Steenkampsberg on 24 October. This species is often found growing in fine white sand derived from the surrounding quartzite rocks.



Fig. 5. *Brachystelma stellatum* is often found growing together with *Ledebouria saundersonii* on the Steenkampsberg as a result of road construction. The large step road cuttings create artificial habitats of moist rocky soil with sparse rocky cover ideally suited to these species requirements.

out at the beginning of the rainless winter. The first heavy frosts of the winter can be expected in early May. In years of late heavy rains, stream banks and seepage areas remain moist until well into the winter.

**SP. AFF *LEDEBOURIA MONOPHYLLA* IN ARTIFICIAL HABITAT ON THE STEENKAMPSBERG**

Many plants in South Africa have adapted to small scale pastoralism and subsistence agriculture. Some species are partially commensal with small-scale pastoralism such as *Zantedeschia jucunda* on the summit of the Leolo Mountains in Sekhukhumeland. (Craib, 2002/2003; 2004). This yellow flowered arum has had its habitat considerably extended by loosely packed stone walls which the local people build to fence in livestock and protect crops. Rock piles left at the edges of agricultural land after it has been cleared extend the habitat of this arum even further.

In western South Africa, agriculture and timber plantations transform habitats into various monocultures. Road building and deep level mining are two activities that respectively extend and preserve habitats. Road reserves and road cuttings preserve plants in areas where the surrounding countryside has become degraded through over grazing and other unsuitable land management practices. Deep-level gold mining, such as occurs west of Johannesburg, has inadvertently protected huge tracts of rocky grassland from habitat degradation and urbanisation (Craib, 2005).

Road reserves have played a significant part in increasing the numbers of sp. aff. *L. monophylla* on the Steenkampsberg, particularly on the summit where there are extensive cuttings or depressions beside the road. This roadside habitat has been stable for several decades since the R 577 roadway was constructed. One bulb population colonising a large road cutting is probably the biggest and most significant on the mountain.

Changes in land use patterns are critically significance for the future of South Africa's bulbous flora. This interesting subject is currently under research by the author for a book.



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(POST-DATED) ADDENDUM: TAXONOMIC NOTE ON THE  
IDENTITY OF *LEDEBOURIA MONOPHYLLA*\*

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FIELD ACCOUNT

The concept of *Ledebouria monophylla* Venter ined (1993) as based on the material at the type locality is a sound and well defined concept. However, this concept is called into question when several other voucher specimens are examined, some of which are closer to *L. sandersonii* while others represent hitherto undescribed taxa, and these do not share synapomorphies with the type as delimited by Venter ined (1993); viz. *Leaf* solitary, appressed; *Inflorescence* solitary, with peduncle depressed; are included in Venter's concept. The plants from the top of the Steenkampsberg as mentioned above by Craib represent a local variant or eco-type of *L. sandersonii* and not *L. monophylla* Venter ined (1993) *sensu stricto*, as the leaves are not always solitary, and the inflorescence is not always solitary and depressed. However, as the epitheton *L. monophylla* Venter has never been formally published, consequently the closest taxon that can be applied to this sub-population referred to by Craib on the Steenkampsberg remains that of *L. sandersonii* (Bak.) Edwards and Venter (2003).

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- Edwards, T.J. & Venter, S. 2003. A revision of *Ledebouria* (Hyacinthaceae) in South Africa. 3. The reinstatement of *L. ensifolia*, *L. galpinii* and *L. sandersonii*. *Bothalia* 33.1:49-51.

\*Editor's Note: *Ledebouria monophylla* *sensu* Venter has never been formally published, a fact that creates a taxonomic dilemma, especially since what actually constitutes *L. monophylla* may not be fully defined. The most recent opinion on this matter, based upon extensive field research, is that above by Andrew Hankey. Perhaps this issue will be resolved in the future.

MORPHOTAXONOMY AND PALYNOLOGY OF TWO ENDEMIC SPECIES  
OF *CRINUM* L. (AMARYLLIDACEAE) FROM THE  
WESTERN GHATS OF INDIA

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ABSTRACT

Two endemic species of *Crinum* L. (Amaryllidaceae) viz., *Crinum brachynema* Herb. and *Crinum woodrowii* Baker have been studied from taxonomic, palynological and distribution viewpoints. These two species have been recollected after a gap of about a century. Considering their narrow range of distribution and rarity of occurrence in the Western Ghats of India, these little known taxa have far reaching floristic and taxonomic implications. The animal-plant interaction and phenological aspects have also been briefly discussed.

**Keywords:** India, Western Ghats, *Crinum brachynema*, *Crinum woodrowii*, Amaryllidaceae, taxonomy, pollen morphology, distribution, ecology.

INTRODUCTION

The genus *Crinum* L. (Amaryllidaceae) is remarkably widespread in the tropics and comprises about 120 species (Mabberley, 2000). It belongs to the tribe Amaryllideae (Baker, 1888; Meerow and Snijman, 2001; Meerow et al., 2003) and sub-tribe Crininae (Snijman and Linder, 1996). In India, it is represented by 12 species, 3 varieties and 1 form (Karthikeyan et al., 1989), of which three species and one form, viz., *Crinum brachynema* Herb., *C. elenorae* Blatt. and McC. f. *elenorae*, *C. elenorae* f. *purpurea* Blatt. and McC., and *C. woodrowii* Baker are endemic to Mahabaleshwar and adjoining areas of the Western Ghats (Sundaraghavan and Singh, 1983; Sundaraghavan and Singh, 1984; Singh and Sundaraghavan, 1986; Ahmedullah and Nayar, 1986; Yadav, 1997; Mishra and Singh, 2001; Gaikwad and Yadav, 2002; Punekar et al., 2004). Recently, *C. brachynema* and *C. woodrowii* were recollected from the Kates Point of Mahabaleshwar after a lapse of 94 and 100 years respectively, and the remaining two, *C. elenorae* f. *elenorae* and f. *purpurea* were

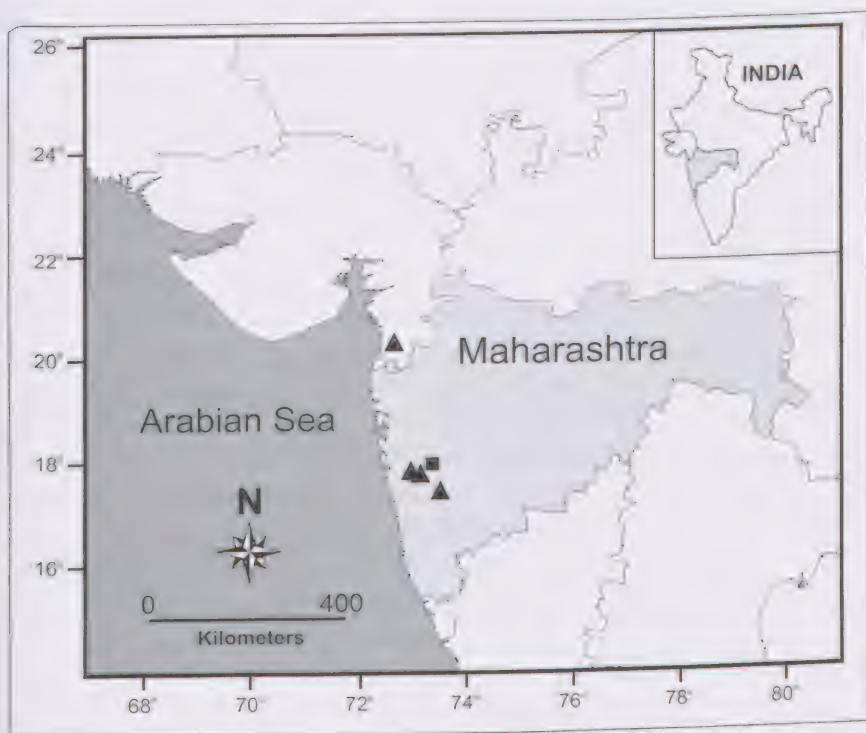


assumed to possibly be extinct (Yadav, 1997; Mishra and Singh, 2001; Gaikwad and Yadav, 2004; Puneekar et al., 2004).

As both *Crinum brachynema* and *C. woodrowii* are restricted to Maharashtra, Gujarat, in a very small pocket of the Western Ghats (Fig. 1), they are considered to be critically endangered (Mishra and Singh, 2001; Gaikwad and Yadav, 2004; Puneekar et al., 2004). Considering their precarious status and narrow range of distribution, a morphotaxonomic review including palynological and ecological observations and phytogeographical aspects is presented in the paper to appraise these little known taxa of Amaryllidaceae from the Indian subcontinent.

### MATERIALS AND METHODS

The specimens of *Crinum brachynema* and *C. woodrowii* were collected during a floristic survey conducted from May 2000 to July 2004 in and around the Western Ghats of Mahabaleshwar, India ( $17^{\circ} 56' . 270''$  N,  $73^{\circ} 41' . 488''$  E)



**Fig. 1.** Localities of *Crinum brachynema* (triangles) and *C. woodrowii* (rectangle) in Maharashtra and Gujarat States of India.

(Fig. 1). The voucher specimens of both species were collected for identification, and which were processed using conventional herbarium techniques and deposited in BSI and K. These two species were identified using the protologue and regional floras such as Herbert (1842), Hooker (1892), Baker (1898), Cooke (1967, Repr.), Deshpande et al. (1993), and Lakshminarasimhan (1996). Special efforts were made to document the habitats, microhabitats, association, phenology, pollinators and potential predators.

Pollen grains were prepared with the acetolysis method of Erdtman (1966). For light microscopy the pollen samples were mounted in glycerine-jelly, sealed with paraffin and then examined with a Leitz Laborlux S research microscope. Permanent slides were deposited at the Pollinarium, Palynological Laboratory of Agharkar Research Institute (A.R.I), Pune. Twenty pollen grains of each species were studied for pollen measurement such as diameter, echinae size (Table 1).

For scanning electron microscopy (SEM) we have followed Juniper et al. (1970) with slight modification. Acetolyzed pollen grains were first washed in 96% alcohol and then absolute alcohol, sputtered with 20 nm of gold with a sputter coater (VG Microtech- Polaron SC 7640, U.K.), and then observed with a Stereo Scan S120 (Cambridge instrument, UK). The terminology applied for pollen grain description in general follows that of Erdtman (1966) and Kremp (1968).

#### KEY TO SPECIES

1. Leaves not forming a pseudostem, folded, linear-oblong, dark green, obtuse at apex; perianth funnel shaped, segments oblanceolate to oblong; stamens included on the throat of perianth tube; filaments very short (ca. 1 cm long); style shorter than filaments, included in perianth tube; pollen grain exine with bulbous excrescences, micro verrucae dense becoming almost areolate ..... 1. *Crinum brachynema*
2. Leaves forming a distinct pseudostem, flat, ensiform, bright green, acute at apex; perianth salver shaped, segments lanceolate; stamens well exerted from the perianth tube, filaments very long (6-7.2 cm long); style longer than filaments, well exerted from the perianth tube; pollen grain exine with echinulate excrescences, micro verrucae distant ..... 2. *Crinum woodrowii*



**Fig. 2.** A. habit of *Crinum woodrowii*; B. inflorescence of *Crinum woodrowii*; C-D. caterpillar of *Polytela* sp. feeding on the flower and fruit of *Crinum woodrowii* respectively; E. flowering habit of *Crinum brachynema*; F. inflorescence of *Crinum brachynema*; G. vegetative habit of *Crinum brachynema*; H. fruiting of *Crinum brachynema*; I. seed germination stages in *Crinum brachynema*.

1. *Crinum*1} *brachynema*  
Herb in Bot. Reg. Misc. 28:  
36, 1842; Hook. f. in Bot.  
Mag. t. 5937, 1871, et in Fl.  
Brit. India 6: 284, 1892;  
Baker in Handb. Amaryllid.  
88, 1888; Woodrow in J.  
Bombay Nat. Hist. Soc. 12:  
522, 1899; Cooke, Fl. Pres.  
Bombay 3: 258, 1967 (Repr.);  
Inamdar in Bull. Bot. Surv.  
India 10: 131, 1968; Shah, Fl.  
Gujarat 2: 668, 1978;  
Sundararagh. and Singh in  
Jain and Sastry (eds.), Pl.  
Cons. Bull. 3: 10, 1983, et in  
J. Econ. Taxon. Bot. 5(1):

163, 1984; Singh and Sundararagh. in *ibid.* 8(1): 35, 1986;  
Bachulkar in Rayat Res. J. 1(2): 114, 1993; Deshp. et al., Fl.  
Mahabaleshwar 2: 589, 1995; Lakshmin. in Sharma et al. (eds.), Fl.  
Maharashtra, Monocot. 94, 1996; Yadav in Pokle et al. (eds.), Flow.  
Pl. Syst. Diver. Part 1: 46, 1997; Mishra and Singh, Endemic and  
Threatened Flow. Pl. Maharashtra. 218, 2001; Gaikwad and Yadav  
in Pullaiah (ed.), Biodives. India. 3: 50, 2004; Puneekar et al. in J.  
Econ. Taxon. Bot. 25(3): 629-630, 2001.

Bulbous herbs, 30-60 cm high; bulbs ovoid, 5-8 cm across. Leaves developing after flowers, folded, bright to dark green, linear-oblong, moderately firm, margin entire, apex obtuse. Scapes one, stout, sub-terete, 30-60 cm long. Flowers 5-20 in umbel, fragrant. Spathe valves (involucral bracts) two, opposite, lanceolate, 3-5 cm long. Pedicel as long as ovary. Perianth funnel shaped; tube slightly curved, greenish, 3-5 cm long; lobes six, pure white, ob-lanceolate to oblong, obtuse, cuspidate, many times longer than stamens, ca. 5 cm x 2 cm. Stamens six, included on the throat of perianth tube; filaments short, ca. 1 cm long, included in tube. Style shorter than stamens. Fruit sub-globose (Fig. 2 E-I).

Distribution and ecology: *Crinum brachynema* is distributed in the Kates Point, Mahabaleshwar and Kas Plateau of Satara District, Maharashtra State,



India (Cooke, 1967; Bachulkar, 1993; Mishra and Singh, 2001; Punekar et al., 2001). This species further extends up to Dharmapur forest range of the Bulsar District, Gujarat State, India (Inamdar, 1968; Shah, 1978), 17° 56'. 270" N, 73° 41'. 488" E, growing at an elevation of ca. 1275 m, generally on the lateritic plateau in margins of semi-evergreen forest, rarely along the hill slopes, in association with *Curculigo orchioides*, *Curcuma neilgherrensis*, *Euphorbia panchganiensis*, *Habenaria crassifolia*, *H. grandifloriformis*, *Hitchenia caulina*, *Pteris quadriaurita*, *Scilla hyacinthina* and *Strobilanthes reticulatus*. In the Kates Point it starts flowering in the months of May and June, fruiting starts from June onwards. In the Dharmapur forest range of Gujarat, it grows at an elevation 700 m, 20° 36' N, 73° 20' E (Inamdar, 1968).

Specimens examined: **India:** Maharashtra: Mahabaleshwar, Kates Point, 10 Jun 2000, Punekar and Datar 186116 (BSI); same locality, 12 Jun 2004, Punekar 186499 (BSI).

2. *Crinum woodrowii* 1} Baker in Bot. Mag. 124: t. 7597, 1898; Woodrow in J. Bombay Nat. Hist. Soc. 12: 522, 1899; Cooke, Fl. Pres. Bombay 3: 257, 1967 (Repr.); Sundararagh. and Singh in Jain and Sastry (eds), Pl. Cons. Bull. 3: 10, 1983, et in J. Econ. Taxon. Bot. 5: 163, 1984; Singh and Sundararagh. in *ibid.* 8: 35, 1986; Deshp. et al., Fl. Mahabaleshwar 2: 591, 1995; Lakshmin. in Sharma et al. (eds), Fl. Maharashtra: Monocot. 97, 1996; Yadav in Pokle et al (eds), Flow. Pl. Syst. Diver. Part 1: 46, 1997; Mishra and Singh, Endemic and Threatened Flow. Pl. Maharashtra. 221, 2001; Gaikwad and Yadav in Pullaiah (ed.), Biodiversity of India. 3: 50, 2004; Punekar et al. in Curr. Sci. 87(8): 1049-1051, 2004.

Tall herbs; bulbs 8.6-16.2 cm in diam., globose-spheroidal, outer tunics brown, membranous. Leaves contemporary with the flowers, sometimes appearing after flowering, many (8-17), 45.5-80 x 4.5-14 cm, ensiform, flat, bright green, slightly glaucous beneath, glabrous, apex acute, white waxy, scabrous along margin; leaf sheaths forming a pseudostem. Scapes one, rarely two, arising from bulb outside the tuft of leaves, stout, compressed, 53.5-82.5 x 1-3 cm, green at base and apex, purple in middle, faintly channeled. Flowers 10-20 in umbel, fragrant; pedicels 1-3 cm long, green with purple tinge. Spathe valves (involucral bracts) two, opposite, 8.7-10 x 2.7-3.9 cm, deltoid, obtuse or acute at apex, margin inflexed, often green, purple tinged, nervate, coriaceous. Bracteoles many, 3-8 cm long, filiform, pale yellow or green. Perianth hypocrateriform (salver-shaped); tube 4-8 cm long,



Fig. 3. Light microscopy photographs of pollen grains of *Crinum brachynema* and *Crinum woodrowii*. A. polar view of *Crinum brachynema* pollen showing aperture and echinate exine; B. equatorial view of pollen of *Crinum brachynema* showing colpus; C. polar view of *Crinum woodrowii* pollen showing aperture; D. equatorial view of pollen of *Crinum woodrowii* showing colpus and echinate excrescence.

A, B, C, D, scale bar = 25  $\mu$ m.

terete, curved, green with purple tinge in flowers, purple in buds; segments spreading equally, white, lanceolate, acute at apex, longer than perianth tube, 8.6–10 x 1–1.8 cm, purple tinged on dorsal median line, shining. Stamens 6; filaments 6–7.2 cm long, filiform, white in lower half and at tip, red in upper half, shorter than perianth lobes; anther lobes versatile, linear, crescent, 1.2–1.5 cm long, yellow, grey when wet. Ovary oblong, 8–10 x 3–4 mm, 3-celled, with numerous ovules in axile placentation; ovules sessile; style terete, filiform overtopping the stamens, 15–15.6 cm long, white in lower half, red in upper half; stigma lobed. Fruit irregular in shape, 3–7 cm across, trilocular, finally bursting, apical rostellum ca. 3 cm long. Seeds ca. 3, large, rounded, testa thick, albumen very copious (Fig. 2 A–D).

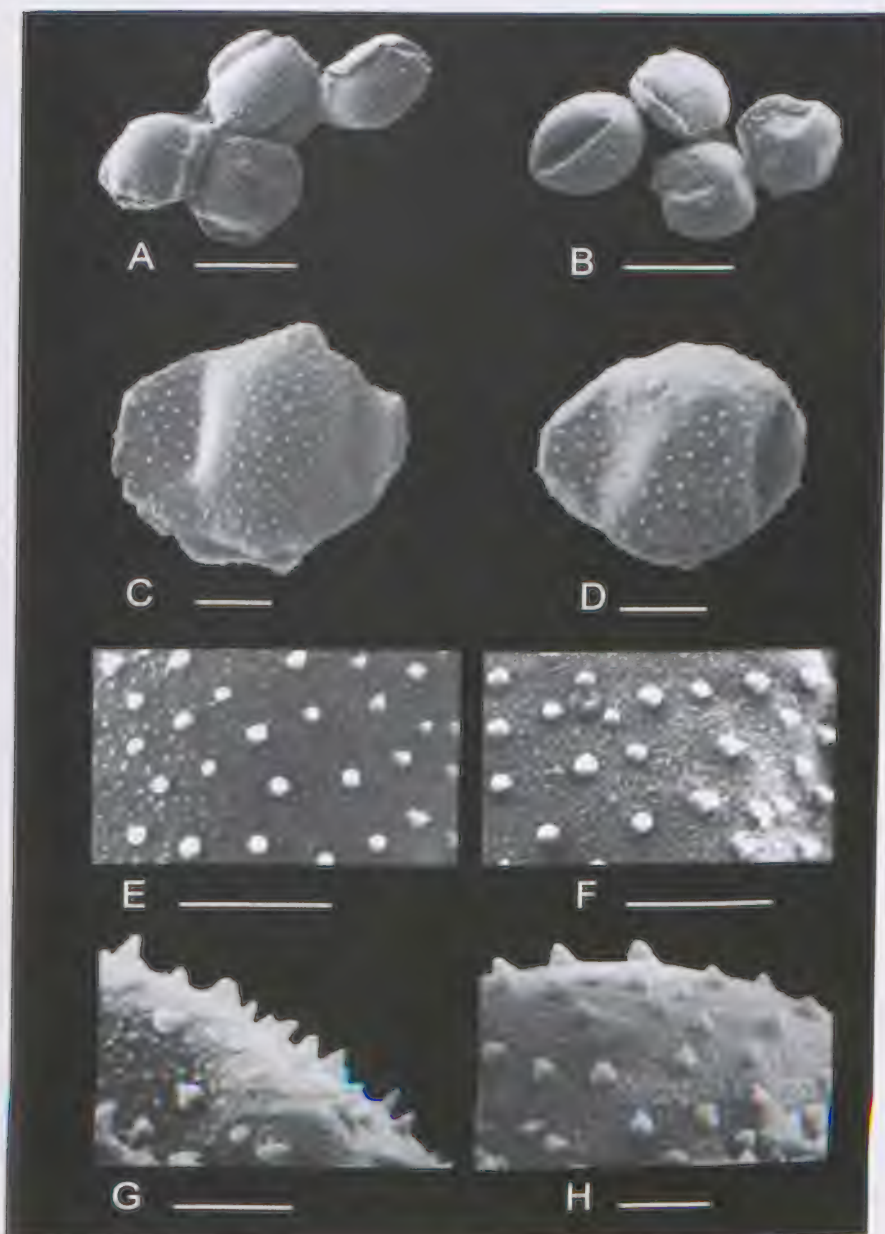
Distribution and ecology: *Crinum woodrowii* is distributed in the Kates Point, Mahabaleshwar Satara District, Maharashtra State, India (Cooke, 1967; Mishra and Singh, 2001; Puneekar et al., 2004), 17° 56'. 270" N, 73° 41'. 488" E, growing at an elevation of ca. 1275 m, on the hill slopes and in valleys in the margins of semi-evergreen forest, in association with *Ceropegia panchganiensis*, *Curculigo orchioides*, *Euphorbia panchganiensis*, *E. pycnostegia*, *E. rothiana*, *Lepidagathis cuspidata*, *Paracaryopsis coelesina*, *P. malabarica*, *Pimpinella heyneana*, *Pinda concanensis*, *Pteris quadriaurita* and *Themeda tremula*. Flowering starts in the months of May and June, fruiting starts from July onwards. The moth caterpillars of *Polytela* sp. were observed to feed on the scapes, flowers and fruit of this species, this being the first report of *Polytela* sp. pest on *C. woodrowii* (Fig. 2 C–D).

Specimens examined: **India:** Maharashtra: Bombay (Presidency), May 1899, *Woodrow, G. M. s.n.* (CAL); Satara District, Mahabaleshwar, Kates Point, 9 Jun 2001, Puneekar, Kavade and Datar 178344 (BSI, K); same locality, 12 June 2004, Puneekar and Kavade 187843 (BSI).

#### PALYNOLOGY

The pollen grains are mono aperturate 1| with the aperture being curved around  $3/4^{\text{th}}$  of the grain, leaving a proximal crust, which is fortified by a granular agglutination (Fig. 4D) or produced into a hillock like structure (Fig. 4C). However some grains look to be clearly one furrowed; i.e. monocolpate (Fig. 4B). The exine is heteromorphic with echinate or echinulate excrescences in *Crinum woodrowii* (Fig. 4G) or bulbous excrescences in *C. brachynema* (Fig. 4H); inter excrescences area is micro verrucate, verrucae being distant in *C. woodrowii* (Fig. 4E) and dense becoming almost areolate in *C. brachynema* (Fig. 4F). The comparative pollen morphology shows very clear differences in exine





**Fig. 5.** Scanning electron photomicrograph of pollen grains of *Crinum woodrowii* and *Crinum brachynema*. **A.** pollen grains of *Crinum woodrowii*; **B.** pollen grains of *Crinum brachynema*; **C.** proximal view of *Crinum woodrowii* pollen showing echinate exine; **D.** proximal view of *Crinum brachynema* pollen showing echinate exine; **E.** dense echinulate excrescence and distant micro verrucae of *Crinum woodrowii*; **F.** relatively sparse bulbous excrescence and dense almost areolate micro verrucae of *Crinum brachynema*; **G.** part of exine of *Crinum woodrowii* showing echinate excrescence; **H.** part of exine of *Crinum brachynema* showing bulbous excrescence.

**A, B,** scale bar = 50  $\mu$ m; **C, D,** scale bar = 20  $\mu$ m; **E, F,** scale bar = 10  $\mu$ m; **G, H,** scale bar = 5  $\mu$ m.

surface ornamentation, both with regards to excrescences and the density of the micro verrucae, which are mentioned in Table 1.

Table 1. Comparison of pollen characters of *Crinum brachynema* and *C. woodrowii*.

| <i>Crinum brachynema</i>                                                                       | <i>Crinum woodrowii</i>                                                                         |
|------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Pollen grains ovoid                                                                            | Pollen grains depressed globose                                                                 |
| Size: 50 x 55 $\mu\text{m}$                                                                    | Size: 58.82 x 64.70 $\mu\text{m}$                                                               |
| Pollen grains mono-aperturate                                                                  | Pollen grains mono-aperturate                                                                   |
| Exine with bulbous excrescences, obtuse at apex; base of echinae ca. 1.25 $\mu\text{m}$ across | Exine with echinulate excrescences, acute at apex; base of echinae ca. 0.9 $\mu\text{m}$ across |
| Micro verrucae dense almost areolate (ca. 420 per 10 $\mu\text{m}^2$ )                         | Micro verrucae distant (ca. 155 per 10 $\mu\text{m}^2$ )                                        |

## DISCUSSION

Both *Crinum brachynema* and *C. woodrowii* are at present restricted to a few pockets of the Western Ghats, and this narrow distribution plus their later rediscovery after a lapse of about a century have floristic and taxonomic implications. In fact, Mishra and Singh (2001) and Gaikwad and Yadav (2004) even thought that *C. woodrowii* was possibly extinct in the wild, while Punekar et al. (2004) considered it a critically endangered species since rediscovering a population of ca. 150 individuals from Mahabaleshwar. *Crinum brachynema* also has a status of critically endangered as suggested by many workers<sup>1</sup>. It has also been observed that these two species are found in association with certain bulbous, rhizomatous and tuberous plants, viz., *Ceropegia panchganiensis*, *Curculigo orchioides*, *Euphorbia panchganiensis*, *Hitchenia caulina*, *Paracaryopsis coelesina*, *P. malabarica*, *Pimpinella heyneana*, *Pinda concanensis* and *Scilla hyacinthina*, within an ecological niche on lateritic plateaus and hill slopes, indicating a habitat preference over other areas. This may be attributed to soil cover of the area which is dominated by a lateritic profile that does not hold water for very long periods. The other probable reason may be that the area is

exposed to a much longer dry period, except for the months of the SW monsoon (Jun-Aug), leading to a stressful environment for the bulbous, rhizomatous and tuberous plants. We have also observed that *C. brachynema* generally prefers lateritic plateaus with soil cover, while *C. woodrowii* generally occurs on the slopes and valleys. Another noteworthy observation is that *C. brachynema* has an association with plants found on the plateaus, whereas *C. woodrowii* is found with plants that are typical of slopes and valleys. As bulbs of these two species are attractive to local inhabitants for medicinal and aesthetic purposes (Cooke, 1967; Bachulkar, 1993; Puneekar et al., 2004), both species are over-exploited, and as such their survival is threatened. Nevertheless, there is potential for sustainable utility of both species, as they have fragrant and attractive flowers that can be commercially utilized in the pharmaceutical and perfume industries, and they can be multiplied through horticultural development practices. By considering all the facts that we suggest for the conservation of these two critically endangered and endemic taxa, total protection should be given to their micro-habitats. *Ex situ* conservation and domestication of these two species in greenhouses and gardens, as well as their reintroduction in the wild in similar habitats, are the most urgent needs. We have also noted that the caterpillar of *Polytela* sp. (a moth) feeds on the scapes, flowers and fruit of *C. woodrowii*, which presents a severe threat to its population as it only feeds on the reproductive parts.

Although palynology of Amaryllidaceae is known (Erdtman, 1966; Kuprianova, 1948), there is hardly any account on pollen of *Crinum* species except that of *C. americanum* L. (Erdtman, 1966; Willard et al., 2004) and *C. pratense* (Nayar, 1990). Comparative pollen morphology of *C. brachynema* and *C. woodrowii* shows very clear differences in exine surface ornamentation, both with reference to excrescence and density of the micro verrucae. It may be noted that the apertural character is primary, and the exine ornamentation is secondary in the levels of phylogenetic importance, the latter of which provides conclusive structural features for taxonomical differentiation of these two species of the genus *Crinum*.

Being bulbous, *Crinum* generally propagate vegetatively. However, seed setting and germination are found within *C. brachynema* (Fig. 2 I) and *C. woodrowii*, and in fact, very common in the former and rare in the latter. We found stingless bees (*Trigona* sp.) and jewel beetles foraging on these two species and are probably associated with pollination. Though three different kinds of dispersal modes, viz., anemochory, atelechory (rain wash) and autochory were reported by Snijman and Linder (1996) in the tribe



Amaryllideae, we have observed at Mahabaleshwar that atelechory is present in both the species as this area experiences significant annual rainfall of ca. 6000 mm during the SW monsoon (Jun-Aug) (Deshpande et al., 1993).

The above high resolution morphotaxonomic characters have far reaching floristic and ecological implications to appraise the potential of these two little known endemic taxa for conservation and sustainable utilization.

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#### ACKNOWLEDGEMENTS

The authors are grateful to the Director, Agharkar Research Institute, Pune, and to the Joint Director, Botanical Survey of India, Pune, for facilities and encouragement. Our thanks are due to P. K. K. Nair, Director, Environmental Resources Research Centre, Thiruvanthapuram, for critical comments on palynological aspects, and to Mr. Rajdeep K. Dongre, Electron Microscopy Laboratory, Agharkar Research Institute, Pune for taking SEM photographs. S. A. P. and R. B. L. acknowledge the Council for Scientific and Industrial Research (C. S. I. R.), New Delhi, for providing Senior Research Fellowships.



## A STUDY OF *DAUBENYA COMATA* IN THE GRASSLANDS NEAR STILFONTEIN, SOUTH AFRICA

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*Photography by Connall Oosterbroek and Carol Knoll*

### INTRODUCTION

*Daubenia comata* has been recorded from widely scattered areas across the high altitudes of the west-central South African interior. At the eastern extremity of its distribution range, the bulbs are often associated with heavy black clay soils and short grassland. This species has been recorded only in small numbers, but it was once extremely common around the Modder River east of Bloemfontein in the Orange Free State and east of Stilfontein in the same province. Bulbs decline rapidly in large numbers under conditions of habitat degradation. Habitats become degraded through invasion of the grassland by alien plants and overgrazing by livestock. The account which follows concerns a two year study of *D. comata* in its habitat south-east of Stilfontein in the Orange Free State.

### THE STUDY AREA

The study area lies at an altitude of about 1300 m close to a large tributary of the nearby Vaal River, one of the largest watercourses in South Africa. The habitat consists of low lying flats or gently undulating areas of heavy black clay soil. The clay area is only about 300 m wide and is flanked by clay loam which comprises the greater part of the soil profile in the general area.

*Daubenia comata* occur plentifully in the clay but very sparingly in the adjacent clay loam. They are scattered over an area about a kilometre in length, the bulk of which has been surveyed for a housing development. Houses have not yet been built, probably owing to the difficulty of laying foundations on the clay. The surrounding loamy areas have numerous houses.

Many parts of the habitat are heavily degraded with annual and perennial weeds. Several weeds are indigenous and probably became established during a previous period when the grassland was consistently overgrazed. Other areas of the surrounding veld, particularly those adjacent to the Vaal River, have been completely transformed by the kikuyu grass *Pennisetum*



**Fig. 1.** *Daubenya comata* habitat at the peak of the flowering season, March 28, 2006. The grass cover was very dense owing to the lack of a grass fire the previous winter and probably the preceding year. Connall Oosterbroek.



**Fig. 2.** A tributary of the Vaal River in flood after prolonged late summer and early autumn rains. Low lying parts of the habitat were periodically flooded for days or weeks during the late summer and early autumn rains in 2006. Connall Oosterbroek.



Fig. 3. The habitat in early winter, June 6, 2005. *Daubeya comata* were most frequent in the open areas such as those in the foreground, Carol Knoll.





Fig. 4. The rose coloured *Daubenya comata* in habitat on April 30, 2006. Connall Oosterbroek.

*clandestinum*. The commonest indigenous plants that have assumed the status of a weed are the daisy, *Cotula anthemoides*, and to a lesser extent, another daisy, *Nidonella hottentotica*. The commonest indigenous weeds benefit *D. comata* in the absence of regular winter grass fires, by preventing excessive accumulations of moribund grass. Thick accumulations of dead grass prevent sunlight from reaching the bulbs, and few bulbs come into flower during long intervals between winter grass fires.

#### BULBOUS AND CORMOUS SPECIES GROWING IN THE SAME AND ADJACENT HABITAT AS *DAUBENYA COMATA*

*Daubenya comata* and *Moraea stricta* are both able to utilise the heavy clay soil in the habitat. *Moraea stricta* flowers in late winter and early spring at a time when the clay is hard, cracked and dry.

*Nerine falcata* is well distributed in the clay loam which borders the *Daubenya* habitat, often growing in scattered large clumps of bulbs. It flowers in late January and February. The same clay loam habitat is frequented by a *Ledebouria* species with canaliculated leaves that appears to be undescribed, and by a *Syringodea* species that also may be undescribed. The *Syringodea* species flowers at the same time as *D. comata* in March and April.

## THE GROWTH CYCLE

*Daubenia comata* is dormant from the end of August until the end of January. Occasional unseasonably late rains in July and August may extend the leafing period of a few bulbs until about mid-September.

The first bulbs to produce leaves normally do so in early to mid-February if there has been consistent good rainfall. These bulbs usually grow in depressions which accumulate water after rains. The majority of bulbs produce leaves during March and early April. Flower buds start to form from the time the leaves emerge, usually taking 4-6 weeks to mature.

The flowering period extends from mid-March to early May, reaching a peak from the last week in March to the third week of April. Occasional bulbs flower in late May and early June.

There was an unusual record of a small group of bulbs flowering in mid-July 2006. The latter bulbs were located at the edge of a flooded gully joining a tributary of the Vaal River. This area was underwater for a few weeks during the peak leafing and bud formation period. It was likely that the late flowering period occurred as a result of these unusual conditions.

Most flowering occurs amongst bulbs growing in open places or where the grass is short. Bulbs in areas with thick layers of dead herbage come into leaf but rarely flower. Winter grass fires play a critical role in keeping the veld sufficiently clear of dead grasses to allow the plants to flower well. The study site lies in an area where fires are actively prevented owing to the nearby housing development. During the non-fire years, mass flowering is restricted to the sides of two infrequently used dirt roads, with one of these roads having a firebreak at its edge. In addition, good flowering occurs each season where there are extensive patches of perennial weeds. The latter have largely replaced the grasses in parts of the study area. Some flowering takes place each season in limited parts of the habitat where the grass cover is naturally sparse.

Flowers are either deep or pale rose, white, or pale to dark lavender. Some white flowers have distinctive lavender anthers. The blooms are strongly scented, having a fragrance reminiscent of frangipani flowers with musky undertones. The probable diurnal pollinators are honey bees and flies. The two different levels of fragrance are interesting, the musky or yeasty tones attracting flies. Bees and flies mostly visit flowers in open situations and where there is sparse grass cover growing nearby. Nocturnal insects do not pollinate the flowers either on cultivated bulbs or those in habitat.

### SEEDING AND SEED DISPERSAL

*Daubenya comata* seeds are well developed a few weeks after pollination but remain green throughout the winter months. The entire infructescence is retracted just below the soil surface after pollination. If there are late rains, these structures are usually covered in clay silt.

The night temperatures often drop to 0°C or lower from late May until early August with severe frost at times. The leaves and seeds forming just below the surface of the soil remain undamaged. The seeds start to ripen in the second half of August. At this stage the infructescence emerges level with the surface of the soil. As the seeds begin to dry out, the entire structure is pushed up 5–7 cm or more above the soil surface. After about 2–3 weeks the dried stem detaches completely from the bulb. The seeds are starting to fall out at this stage and are further distributed as the dry infructescence is blown about by the wind. Some seeds are dispersed when a dry infructescence is crushed under the wheels of a vehicle. All the seeds are exposed when crushed under wheels. They are too heavy to be dispersed further by wind, but they may be transported around the habitat by runoff water when the rains begin in October.

*Daubenya comata* is capable of producing huge quantities of seed in open habitat readily reached by pollinators. Twenty dried infructescences randomly collected from open parts of the habitat on September 12, 2006 yielded a total of 569 fertile seeds (Table 1). Germination rates are high for this species, and the habitat can quickly become crowded with young bulbs.

Seeds become buried in the habitat before and during the early summer rains. Germination does not however occur until February and March at about the same time the mature bulbs begin to sprout leaves.

### DAUBENYA COMATA IN THEIR MODERN HABITAT

*Daubenya comata* is essentially living in an altered grassland habitat in the study area. The lack of regular winter grass fires has had the effect of restricting the bulbs to open habitats. In addition, porcupines, *Hystrix africae australis*, are very destructive in some years such as during the winter of 2006. These animals are attracted by masses of *Daubenya* bulbs growing close together. They dig into the soil to a depth of 10–30 cm or more and eat nearly all the bulbs. Porcupines feed last in areas containing the fewest numbers of *D. comata* such as denser grassland. These latter areas are usually exploited by the porcupines once the open places have largely been cleared





Fig. 5. Lavender, pink and white flowered *Daubenia comata* growing together in the clay habitat, April 30, 2006. Connall Oosterbroek.



Fig. 6. Pale rose flowered *Daubenya comata* in full flower, April 30, 2006. Connall Oosterbroek.



Fig. 7. White and pink flowered *Daubenia comata*, April 30, 2006. Connall Oosterbroek.



Fig. 8. Pale rose flowered *Daubenia comata* at the peak of the flowering season, April 30, 2006. Connall Oosterbroek.





**Fig. 9.** White flowered *Daubenya comata* in habitat, April 30, 2006. Connall Oosterbroek.



Fig. 10. White flowered *Daubenia comata* sometimes have distinctively pink tinged anthers. Connall Oosterbroek.

of bulbs. The areas which have the least numbers of bulbs are usually used as feeding areas towards the end of winter during late July and August. Sometimes the animals dig up single bulbs scattered throughout the habit, and these shallow cavities are dug just deep enough to extract the bulbs.

An estimated three quarters of the existing population of *D. comata* was destroyed by porcupines during the winter of 2006. It will probably take several decades for the population of bulbs to build up to former numbers, should the animals not feed on these bulbs to any significant extent during subsequent winters.

The countryside near the *Daubenia* habitat harbours large numbers of porcupines. These rodents have become common in the region owing to the elimination of natural predators and to the increased food supply provided by agricultural crops.

In addition to *D. comata*, porcupines attempt to feed on *N. falcata* which is common in the adjoining habitat. A few *Nerine* bulbs have been excavated by porcupines, superficially nibbled and then discarded. These bulbs may be toxic to the rodents. The *Ledebouria* species and the *Syringodea* species have not been eaten by these foraging rodents.



Fig. 11. *Daubenya comata* at the beginning of the winter, June 6, 2005. Cracks have started to form in the clay around the plant, typical of the habitat in the winter months. Connall Oosterbroek.

#### ADAPTIONS OF *DAUBENYA COMATA* TO GROWING IN CLAY

Few bulbous genera frequenting the grassland interior of South Africa have evolved that thrive in clay. However, some bulbous species have adapted to clay based soil, but these are usually found flowering in pans of water or marshes inundated at flowering time. Typical examples of the latter are *Crinum bulbispermum*, *Gladiolus papilio* and *Nerine platypetala*.

The clay in the *Daubenya* habitat has the characteristic of shrinking and cracking during the later part of the winter and in the early summer before the rains. During the rains the clay absorbs a great deal of moisture and becomes thick and glutinous. *Daubenya comata* grows and flowers in the autumn at a time when the clay is at its wettest and most stable condition.

Towards the end of the winter during July-September, many *Daubenya* bulbs become exposed in the wide fissures that open up in the clay. The bulbs stick to the sides of the clay walls in the fissures. They may be exposed to air and sunlight for 3-4 months before the soil expands once more and the cracks seal up with the beginning of the summer rains.

Large quantities of seed fall into cracks in the dried clay at seeding time in late winter and early spring. These lodge in places where they are too deep to germinate when the clay becomes moist and the cracks seal over.





**Fig. 12.** *Nerine falcata* flowers in large numbers at the edge of the habitat about 5-6 weeks earlier than *Daubenia comata*. In the background are gathering storm clouds typical of many summer afternoons. Connall Oosterbroek.

#### INTRODUCING *DAUBENYA COMATA* TO POPULAR CULTURE

*Daubenia comata* is a good subject for popular horticulture. It has an attractive, broad, creamy-yellow vertical stripe down each leaf and strongly scented attractive flowers. The bulbs are also easily stored out of the growing medium during dormancy. They thrive in most types of soil even though they are most abundant in clay areas in their natural habitat.

Hadeco, a large bulb company based in Johannesburg, South Africa, will be introducing *D. comata* to popular horticulture in the near future. The bulbs bloom and seed well in cultivation in Johannesburg. The seed producing stocks can be grown in large containers in open sunny places where they can be regularly visited by pollinators throughout the flowering period.

Table 1. Ripe *Daubenia comata* fruit randomly sampled in open areas of the habitat on September 12, 2006.

| A. Fruit size ranging from 0.6 cm tall x 1.0 cm wide to 1.4 cm tall x 1.2 cm wide. | B. Fruit size ranging from 2.0 cm tall x 1.2 cm wide to 2.2 cm tall x 1.8 cm wide. |
|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| 1. 15 fertile seeds, 3 infertile seeds                                             | 1. 31 fertile seeds                                                                |
| 2. 23 fertile seeds                                                                | 2. 34 fertile seeds, 1 infertile seed                                              |
| 3. 10 fertile seeds                                                                | 3. 40 fertile seeds, 1 infertile seed                                              |
| 4. 8 fertile seeds                                                                 | 4. 27 fertile seeds                                                                |
| 5. 8 fertile seeds                                                                 | 5. 41 fertile seeds                                                                |
| 6. 9 fertile seeds                                                                 | 6. 77 fertile seeds                                                                |
| 7. 13 fertile seeds                                                                | 7. 73 fertile seeds                                                                |
| 8. 16 fertile seeds, 1 infertile seed                                              | 8. 36 fertile seeds                                                                |
| 9. 14 fertile seeds                                                                | 9. 42 fertile seeds                                                                |
| 10. 5 fertile seeds, 2 infertile seeds                                             | 10. 47 fertile seeds                                                               |
| Total fertile seeds = 121                                                          | Total fertile seeds = 448                                                          |
| Total infertile seeds = 6                                                          | Total infertile seeds = 3                                                          |
| Averages seeds/fruit = 12.1                                                        | Average seeds/fruit = 44.8                                                         |



Fig. 13. *Daubenia comata* fruit at the time the supporting peduncle is pushed up above the ground and the seeds are ready for liberation into the environment. Connall Oosterbroek.



THE IDENTITY OF *CRINUM CRASSICAULE* BAKER  
(AMARYLLIDACEAE)

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BACKGROUND

While camped at Koobie Wells (Köbis) in Ngamiland, Botswana, botanical artist Thomas Baines sketched a watercolor of an unknown *Crinum* in October 1861. He only had a depauperate scape available to illustrate, the specimen having been brought to him by a traveling companion. Needless to say, the watercolor (Fig. 1) was peculiar, and Baines was aware of its imperfections. Quoting Baines (1864): "I sketched a very beautiful umbel of white and pale purple flowers brought home by Chapman, apparently a kind of amaryllis... The flower had been too long gathered to restore itself to form when placed in water, but I believe that when fully opened they turn gracefully outward like the many similar flowers of the country." The umbel consisted of 10 buds and one drooping withered flower; Baines illustrated the withered flower, but he promoted the buds to anthesis. He also wrote in pencil in the margin of the painting that the specimen had been collected on the flats at Koobie Wells, the umbel was badly faded, and that the perianth segments were more recurved in fresh flowers than shown in the watercolor. Adjacent to these comments, he sketched a small trumpet-shaped flower (Fig. 2) characteristic of Subgenus *Codonocrinum*. (The drooping withered flower demonstrated in the October 1861 painting – with inwardly collapsed segments enclosing the filaments and style – also was characteristic of Subgenus *Codonocrinum*.) After completing the watercolor, Baines pressed the depauperate scape (Fig. 3); no leaves accompanied the specimen.

Baines maintained detailed maps during his travels. He indicated that Koobie Wells was located circa 45 km south of Lake Ngami, situated in an arid region falling within the fringes of the Kalahari Desert. While still camped at Koobie Wells, Baines painted another flowering *Crinum* in situ (Fig. 4) in November 1861. Quoting Baines: "Sketched a couple of beautiful amaryllidae with which the country now abounds. I find it of no use whatsoever to bother myself with trying to paint the background round the outline of the flower, ..." (Baines painted two amaryllids that November day in



Fig. 1. *Crinum crassicaule* Baker, painting by T. Baines, October 1861. (Courtesy of K.)



Fig. 2. Penciled flower by T. Baines in margin of Figure 1 painting. (Courtesy of K.)



Fig. 3. *Crinum crassicaule* Baker. Botswana. Koobie Wells, Ngamiland, T. Baines, s.n., October 1861, Holotype, K. (Courtesy of K.)





Fig. 4. *Crinum crassicaule* Baker, painting by T. Baines, November 1861. Lectotype illustration per N.E. Brown. (Courtesy of K.)

1861, the other being *C. lugardiae* N.E. Brown, although the latter painting was never formally identified or acknowledged by either Baker or Brown; it lies unidentified in the archives at Kew.)

When Baker received Baines's pressed specimen and paintings at Kew, he classified it as a new species of Subgenus *Crinum*. Baker's original handwritten identification on the holotype specimen stated: "*Crinum crassicaule* Baker. South trop. Africa. Oct. Nov. 1861. Coll. T. Baines." (The November date ties together both illustrations.) Baker's description of this species was very brief.

N.E. Brown (1909), a coworker of Baker at Kew, worked on the identification of botanical specimens collected during Major Lugard's 1896–1898 expedition to Kwebe Hills in Ngamiland, Botswana. While doing so, Brown equated painting #45 by Mrs. Lugard with the type specimen for *C. crassicaule* Baker and Baines's two paintings. Brown wrote on Baines's November 1861 painting that it represented the type illustration, and he published an emended detailed description for *C. crassicaule*.

Verdoorn (1969) was confused by the type specimen for *C. crassicaule* Baker. She only examined black and white photographs (taken by E.G.H. Oliver) of the type specimen, Baines's two paintings, and Mrs. Lugard's #45 illustration; she was unaware of Baines's handwritten comments in the margin of the October 1861 painting as well as the penciled sketch of the funnel-shaped flower. She concluded that Baines's October and November paintings represented two different taxa. Verdoorn dismissed Brown's account, claiming that it also represented two different taxa, and she implied that Mrs. Lugard's #45 illustration depicted a taxon belonging to Subgenus *Crinum*. (The latter interpretation was fallacious; Mrs. Lugard's #45 illustration consisted of two sheets, one displaying a spherical bulb with undulant leaves, a short scape with flowering umbel, and an unambiguous funnel shaped flower characteristic of Subgenus *Codonocrinum*. Mrs. Lugard's illustration was highly compatible with *C. crassicaule*.) Having thus stated her opinion, Verdoorn defined a new species of Subgenus *Codonocrinum*, *Crinum foetidum* Verdoorn. She acknowledged that Baines's November 1861 painting was cospecific with *C. foetidum*.

Verdoorn (1973) then completely muddled the situation. She published what she believed to be *C. crassicaule* Baker, complete with a botanical illustration – unfortunately she chose a species of Subgenus *Crinum* occurring in the Okavango Delta swamps and the flood plains of the Zambezi River that had been described previously, *Crinum subcernuum* Baker. In support-



Fig. 5. *Crinum crassicaule* Baker. Botswana. 50 km east of Maun, Ngamiland. January 1992.

ing her premise, Verdoorn erroneously claimed that Baines had collected *C. crassicaule* in the Okavango swamps north of Lake Ngami. Verdoorn's mistaken account of *C. crassicaule* was widely disseminated. Nordal (1977) and Lehmler (1992, 1997) commented that Verdoorn had misidentified *C. subcernuum* as *C. crassicaule*.

The confusion generated by Verdoorn led to a formal attempt to declare *C. crassicaule* Baker an illegitimate taxon (Nordal et al, 2002), but this proposal was rejected by the Committee of Spermatophyta. However, lest confusion persist because the type specimen is a depauperate scape lacking leaves, the designation of a topotype specimen is in order.

#### SELECTING THE TOPOTYPE SPECIMEN

In January 1992, Dave Hardy, Senior Horticulturist from the National Botanical Institute in Pretoria, and I traveled to Maun, Botswana, where we rented a vehicle and began exploring the region about Lake Ngami. Our first encounter with *C. crassicaule* occurred 50 km east of Maun (Fig. 5). Later we traveled south to Kwebe Hills (Quaebie Hills, Kgwebe Hills) where we were driven out by a fierce thunderstorm and were fortunate to escape back to the main tarred highway; we did not observe any *Crinum* at Kwebe Hills, but our encounter was very brief. We traversed Lake Ngami, which





**Fig. 6.** Topotype inflorescence, *Crinum crassicaule* Baker, May 2005.

was currently dry but fortunately there had been some earlier rainfall. Periodically we observed bulbs in leaf of *C. crassicaule*, but beginning 11.5 km north of the Kuke Animal Control Gate at the Ghanzi District boundary until 5.5 km north of the Kuke Gate, *C. crassicaule* was locally common. Per Baines's map, Kuke Gate was located very close to the site of Baines's camp at Koobie Wells (my estimate from Baines's map was less than 10 km); however, the locals and guards at Kuke Gate were not familiar with a location called Koobie Wells or Köbis. (The similarity between "Kuke" and "Koobie" is tempting to speculate upon.) It was during this excursion south of Lake Ngami that a bulb was found in fruit, and the seeds were collected. From these seeds, a flowering bulb was raised in cultivation, and a herbarium specimen was prepared to become the topotype specimen for *C. crassicaule* Baker (Fig. 6-7).

*Crinum crassicaule* Baker. Handbook of the Amaryllidaceae, p. 85, 1888.

Type: Botswana. Koobie Wells, Ngamiland. T. Baines, s.n., October 1861, K.

Type Illustration (per N.E. Brown): T. Baines, November 1861, K.

Emended: N.E. Brown. Bull. Misc. Inform. No.3:142, 1909.

Topotype (designated herein): Botswana. 41 km SW of Toteng, Ngamiland. Seed collected 25 January 1992 and cultivated in Texas; Lehmler 1950, May 2005, TAMU.

Syn.: *Crinum foetidum* Verdoorn. Bothalia 10: 56-58, 1969.

was now a dry lake bed overgrown with trees. Then we set off to our main destination, the road from Toteng to Ghanzi (Ghanze, Gantsi) that traveled south of Lake Ngami. The terrain was Kalahari Desert sand, a very arid ecology, and it



**Fig. 7.** *Crinum crassicaule* Baker. **Botswana.** From seed collected 41 km SW of Toteng, Ngamiland, 25 January 1992, and cultivated in Texas, Lehmler 1950, May 2005, Topotype, TAMU.

**Description** (from living plants):

Bulbs large, solitary, spherical, covered with a thick, dark brown parchment-like tunic that turns black when wet, 10.0+ cm diameter, tapering to an underground neck to 14 cm long; with tough wire-like yellowish-white roots to 0.4 cm diameter. Leaves 5-12, forming a rosette, low arching to sprawling on the ground, broadly channeled and often undulant, lacking a midrib effect, margins distinctly ciliate, containing small wooly fibers when torn with torn edges emitting a foul scent, widest near the base, tapering, dull bluish green, 29.5-80.5 cm long and 10.5-21.0 cm wide. Scape short, subterranean to 16 cm long. Spathe valves reflexed at anthesis, dull red with greenish streaking, 18.5-19.5 cm long by 4.8-6.0 cm wide. Umbel 5-17 flowered; flowers zygomorphic, nocturnally opening, suberect at anthesis but inclining soon after sunrise, strongly scented, honey bees noted. Pedicels 2-3 cm long. Ovaries shiny light green, 1.1 cm diameter and 2.0 cm long. Perianth tubes straight at anthesis, becoming curved soon after sunrise, 10.5-12.0 cm long. Buds initially erect, then inclining outward with curved perianth tubes to a horizontal position, before arising to a suberect position with straight perianth tubes at anthesis. Segments lanceolate, distally recurved, white with a pinkish keel only on the dorsal surface, unequal with the inner slightly broader and shorter, 12.5-16.0 cm long and 1.9-3.1 cm wide. Filaments distally curved, white, unequal with those attached to the inner segments longer, 6.8-9.5 cm long. Style white, colored pinkish purple distally, capitate, 11.5-14.5 cm long. Anthers bowed at maturity, light tan, pollen light yellowish tan. Fruit ovoid to slightly lobulated, usually bearing an apical rostellum 1.0-6.0 cm long, green turning light yellow at maturity, indehiscent, 2.5-4.5 cm diameter. Seeds 1-6 per fruit, ovoid to focally angulated from compression by adjacent seeds, papillose, turning brownish black at maturity, foul smelling, 0.8-2.0 cm in diameter.



## ACKNOWLEDGEMENTS

I wish to thank personnel at the Herbarium (K), Royal Botanic Gardens, Kew, United Kingdom, for their assistance in locating the paintings and specimens referenced in this manuscript, particularly Mrs. Jill Cowley. My appreciation is extended to Dr. Piet Vorster, Department of Botany and Zoology, University of Stellenbosch, South Africa, for his critical review of this manuscript.

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Fig. 8. Topotype bulb in fruit, *Ginum crassicaule* Baker, July 2005.



Fig. 9. *Ginum crassicaule* Baker in cultivation. Photograph taken approximately 15 minutes after sunrise while perianth tubes were still erect. Note similarity with Baines's October 1861 painting including the drooping withered flower.

## THE AUTECOLOGY OF *STRUMARIA SPECIOSA* ON THE SONNENBERG, SOUTH-WESTERN NAMIBIA

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*Photography by Connall Oosterbroek and Carol Knoll*

### FIELD ACCOUNT

*Strumaria speciosa* is one of three recently described species (Snijman, 2005) and has so far only been recorded from the steep uppermost south-facing slopes of the Sonnenberg. The summit slopes of the mountain lie at an altitude of just under 1000 m. The Sonnenberg is the highest of several mountains adjacent to the Orange River to the southeast of Rosh Pinah.

The region in which the species grows is very remote and inaccessible. The bulbs may well occur on the peaks north of the Sonnenberg, one of which rises to an altitude of 1219 m, and also on the peaks around the Namusberg to the northwest, the highest of which lies at an altitude of 1228 m.

The summit and upper slopes of the Sonnenberg attract moisture from cold fronts during the winter months mostly between May and September. There is usually some soft-penetrating rain above 800 m during poorly-developed frontal systems which fail to bring any precipitation to the lower slopes and valley floors.

Present indications are that *S. speciosa* is found growing on dolomite in soft, moisture-retentive, very fine-grained soil. The bulbs occupy three distinct habitat niches. They grow in deep soil pockets between rocks on broken cliff faces, in deep soil on scree immediately below the cliffs, and are sparsely scattered near succulent shrubs up to about 90 metres from the cliffs. These are all positions which attract an abundance of moisture during fog or rain. These *Strumaria* are shaded for most of the day during the winter months, and the soil where they grow remains moist for several days after rain.

At the locality where the investigation was conducted, most of the bulbs grew singly, a few to many metres from one another. Occasionally scattered groups of 2-3 plants were found. The largest bulbs had necks ranging in length from 8-10 cm tall at the point where they emerged from the ground. The bases of the bulb necks, just above the ground, ranged from 2.5-4.5 cm





**Fig. 1.** The striking fan-shaped foliage of *Stromanthe speciosa*, showing the exposed bulb neck and remains of leaves of the previous winter growing season. Photograph by Graham Duncan.



Fig. 2. *Strumaria speciosa* leaves develop quickly after the bulbs receive moisture in April or early May. The bulb necks are typically well exposed above the surface of the soil. Photograph by Connall Oosterbroek.



Fig. 3. *Strumaria speciosa* bulbs in full leaf at the end of May. After four weeks of growth, which started at the end of April, leaves are fully developed. Leaves remain in this state until September and then die back with the beginning of warmer weather. Photograph by Connall Oosterbroek.



**Fig. 4.** *Stumaria phondithica* in leaf is usually indistinguishable from *S. speciosa*. Photograph taken in late April at the beginning of the leafing season. Photograph by Connall Oosterbroek.



**Fig. 5.** *Stumaria phondithica* in full leaf at the end of May. Leaves of this species are fully developed within a month, reflecting the same progress of leaf development that occurs in *S. speciosa*. Photograph by Connall Oosterbroek.



in width. Most of bulk of the bulb necks was comprised of masses of old compacted, water-absorbent bulb tunics that resembled blotting paper in texture.

Smaller bulbs had necks ranging in length from 5.5-6.5 cm at the point where they emerged from the ground. The compacted masses of old bulb tunics ranged in width from 0.5-1.5 cm.

The fan of falcate leaves and the exposed bulb necks with water absorbent qualities are likely to play an important role in trapping moisture and irrigating the bulbs. Further research on this interesting subject is required.

The small population of bulbs widely scattered across the habitat is not readily explained. It is probably linked to the erratic flowering of individual plants and to the extremely rugged and precipitous characteristics of the habitat. Little seed would land in places where it could take root and develop into young bulbs. The population size is also limited by the restricted amount of habitat available. The bulbs only occupy the south-facing slopes close to the summit of the Sonnenberg, and much of this terrain consists of cliffs and stony scree with limited niches for the bulbs to colonise.

The *Strumaria* share their habitat with a rich bulbous and geophytic flora. *Boophane ernesti-ruschii* grows at the same altitude as does an apparently undescribed tuberous *Othomma* with a few large rounded succulent leaves like those of *Tylecodon singularis*.

## NOTE

*Strumaria phonolithica* occurs on the Aurus and Klinghardt Mountains in the Sperrgebiet (forbidden diamond area) in the Namib Desert southeast of Lüderitz. In leaf, *S. phonolithica* is usually indistinguishable from *S. speciosa*. Likely these two species are closely related.

## REFERENCE

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## CRINUM ACAULE AND ITS ARTIFICIAL HABITATS IN ZULULAND, KWAZULU NATAL, SOUTH AFRICA

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### HABITAT DISCUSSION

The habitat of *Crinum acaule* in Zululand has been transformed in many areas where coastal grasslands have been replaced by timber plantations. This is particularly evident west of Lake St. Lucia, between Hluhluwe and Matubatuba. Further south around Monzi the modern countryside consists of a mixture of timber plantations and sugar cane fields.

The autecology of *C. acaule* has been discussed by Craib and Blackmore (1997). The purpose of this short account is to examine in more depth the artificial habitat frequented by *C. acaule* in areas heavily planted with timber and in sugar cane fields. In these areas *C. acaule* occurs on road reserves, on extensive grassland corridors for the placement of pylons between timber plantations, on grassy runways of small aerodromes, and also on verges of timber-plantation access roads. All of these habitats share similar characteristics. The grass is regularly mowed particularly in the summer growing season. The soil is shallowly rotovated (dug up) by machinery to eliminate weeds and timber. Plantation debris (leaves, bark, twigs) is periodically dumped on some road reserves for collection by logging trucks.

In its natural habitat *C. acaule* is part of the coastal grassland ecosystem. Many grassland plants are dependent on fire to clear moribund grasses and shrublets from the habitat. *Crinum acaule* fails to flower if the habitat becomes thickly covered with an accumulation of dead plant material or when the grass cover is dense. In years when the grass is thick and tall, flowering is restricted to naturally open areas or those that have been kept open by animals such as warthogs (Craib and Blackmore, 1997). *Crinum acaule* differs from all other *Crinum* species in South Africa except *C. minimum* sensu Verdoorn in that flowers appear at or just above ground level. This renders the species very susceptible to degradation via the invasion of weeds, woody plants and grasses if there is a lack of periodic grass fires. In many areas where timber is grown, such as the afforested western areas of the Greater St. Lucia Wetland Park, fire is actively excluded except for local-



Fig. 1. *Crinum acaule* growing along a broad road reserve in the Greater St. Lucia Wetland Park near Charters Creek. The short mowed grass and rotovated soil is visible in the foreground with a typical plantation of exotic *Eucalyptus* in the background.

ized areas where burns are carefully managed. In contrast, *C. delagoense* is better suited to degraded or irregularly burnt habitat on the northern Zululand coastal plain. The latter's flower umbels are held aloft from grass cover, and larger bulbs manage to flower even when the grass is dense.

*Crinum acaule* has an extended flowering period in artificially maintained grassland habitats. This lasts mostly from September to late November, and one large bulb often produces several scapes during this time. In this respect *C. acaule* is quite unlike other South African *Crinum* species. Its flowers, being highly colourful and large, stand out amongst the short mowed grass and are very attractive to pollinators. They are strongly fragrant from the time they first open usually in the late afternoon or early evening until the time they wither a day or two later.

Flowering plants in areas densely planted with timber often have their reproductive biology affected in a negative manner, failing to attract pollinators. This applies particularly to many of the grass *Aloe* species (Craib, 2005). However, extensive timber plantations do not appear to affect the pollination of *C. acaule*, since bulbs growing in the artificial grassland habitat are regularly found in seed. *Crinum acaule* is one of only two South African *Crinum* species that bears small numbers of seed. The latter are very



large with a distinctive rugose covering. They lodge readily around the adult plants. Clumps of 4–14 bulbs are common in the artificial habitats. In natural grassland *C. acaule* rarely forms bulb clusters as opportunities for flowering and producing seeds are more limited.

An undetermined number of seeds and young bulbs are destroyed during mowing and rotovating. These grass cutting and weed controlling activities slow down the recruitment of young bulbs to the artificially maintained *C. acaule* populations. Bulb clumps would be much larger were weed control measures only carried out during the winter and late summer after seeds had the opportunity to establish themselves as young bulblets.

South Africa's grasslands are set to undergo increasing levels of habitat destruction and degradation during the course of this century. It will thus become increasingly important to assess artificially created and maintained habitats for the preservation of different plants. In the case of *C. acaule*, the only bulbs occurring over a wide area of natural grassland habitat are those in the Greater St. Lucia Wetland Park. The latter locality represents a fraction of the total area once frequented by this species. It is important to note that outside of Greater St. Lucia Wetland Park, *C. acaule* populations are well maintained solely as a result of the methods used for maintaining tim-



**Fig. 2.** *Crinum acaule* prior to anthesis at dusk along a mowed road reserve near Charters Creek, Greater St. Lucia Wetland Park.



Fig. 3. *Crinum acaule* flowers shortly after anthesis in the early evening. Photograph taken at a recently mowed road reserve near Charters Creek, Greater St. Lucia Wetland Park.



**Fig. 4.** Large bulbs of *Crinum acaule* producing several scapes simultaneously. Photograph taken along a road reserve near Charters Creek in the Greater St. Lucia Wetland Park.

ber plantations, power line reserves and road reserves. Any changes to the status of these artificially maintained areas could have a detrimental impact on the existing populations of this species.

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## CONVERSATION POLICY STATEMENT

The following policy statement was developed by an international consortium which included the representatives of the International Bulb Society, Alpine Garden Society (UK), North American Rock Garden Society, Chicago Botanic Garden and American Daffodil Society.

The total populations and diversity of many plant species across the world are in decline. Habitats are faced with increasing threats of destruction as mankind continues to develop the environment for urban, agricultural and recreational uses.

Plant societies are dedicated to understanding, preserving, growing, selecting, propagating and appreciating the natural flora of the earth. As plant enthusiasts, we share a responsibility to embody the principles of conservation in such a way that our activities as gardeners, horticulturists and botanists are in harmony with the wider concerns of preserving the environment.

Collection of plant material from the wild has left some species of plants facing extinction. The memberships of the undersigned organizations have agreed to abide by the following Code of Best Practice:

- We strive to support organizations that seek to preserve valuable wildlife habits as the sources for genetic variations and naturally thriving plants for generations to come.
- We do not support the practice of wholesale collection for resale of wild plants from their natural habitats. We condemn the practice of misleading the public by calling such collected plants nursery grown or nursery propagated.
- We support the practice of collection of seeds, cuttings, divisions, and the occasional selected individual from large populations of wild plants by knowledgeable and responsible individuals for the purposes of growing, studying, selecting, hybridizing and ultimately propagating and distributing such material to others.

Our support is tendered only where the value of such collection lies in scientific research, preparing herbarium records or propagating such material for horticultural or conservation purposes, and is further based upon the provisos that:

- Discretion is exercised in collecting seed, such that only part of the seed productions is taken.
- Living material is collected only in small amounts.

- In the case of rare plants, material is collected only upon a very limited basis and only where there is sufficient local stock to successfully perpetuate that population.
- We encourage our members to familiarize themselves with and comply with national and local legislation or regulations regarding the conservation of habitats and the collection of plant material.
- We support the sentiments of the various international conventions, such as CITES and the Biodiversity Convention.
- We welcome like-minded organizations to agree to follow this Code of Best Practice.

Schedules: Each plant society or conservation organization is encouraged to list species or classes of plants whose dwindling populations are of imminent concern to them. In this way, all groups can be guided by the knowledge of the specialists and share their concerns.

Adopted by International Bulb Society, July, 2000

Adopted by American Daffodil Society, November, 2000

Adopted by North American Lily Society Board, January 2001

## CONTRIBUTOR'S GUIDELINES FOR HERBERTIA

*Herbertia* is an international journal devoted to the botany and horticulture of geophytic plants. A special emphasis of the journal is the Amaryllidaceae and other petaloid families rich in bulbous, cormous or tuberous plants, but articles treating any aspects of geophytes are welcome. Articles may be formal (scientific), informal (practical, informative), field reports, historical accounts, addendum notes, and timely reports of Society activities.

Contributors are asked to adhere to the following guidelines when submitting papers. Manuscripts departing grossly from this format will be returned to the author(s) for revision.

1. Scientific or technical articles (e.g., taxonomy, plant physiology) submitted for publication in *Herbertia* will often be sent to an appropriate reviewer for peer review. Any article may be scrutinized for accuracy by an appropriate reviewer. Final decision for "acceptance" or "acceptance with revision" of manuscripts resides with the Editor; authors of rejected articles may appeal the decision to the IBS Board of Directors.
2. Manuscripts **must** be typed or produced with legible ink jet or laser printers on 8 1/2 x 11 inch paper. Double spacing should be used throughout.
3. An electronic copy of the manuscript **must** accompany the written copies. This should be provided on a CD/DVD or sent to the Editor as an e-mail attachment. Microsoft Word for Windows versions 6, 7, 97, 2000 and XP are preferred.
4. Scientific papers may be prefaced with a short abstract if appropriate and so desired.
5. Descriptions of taxa should follow conventional form as to construction of descriptive paragraphs, specimen citation, and synonymy. Use the following examples as a guide or consult journals such as *Systematic Botany*, *Brittonia*, or *Annals of the Missouri Botanical Garden*:

*Callipsyche aurantiaca* Baker. Refug. Bot. 3:t. 167 (1869). Neotype: Ecuador, El Oro, Ayabamba, 200 m, Andre 4262 (K).



*Eucrosia morleyana* Rose. Addisonia 7:3-4, pl. 226 (1922). Type: Ecuador, Chimborazo, Huigra, 4000 ft, Rose & Rose 22593 (holotype, US; isotypes, GH, NY, S).

*Eucrosia eucrosioides* var. *rauhiana* (Traub) Traub. Pl. Life 22:62 (1966).

*Callipsyche eucrosioides* var. *rauhiana* Traub. Pl. Life 13:61 (1957). Type: Ecuador, Azuay, Pasaje, 300 m, Rauh & Hirsch E15 (holotype, MO)

Bulb large, 7.7-10 cm long, 6-7.7 cm in diameter; tunics tan-brown; neck (2.5)-5-8 cm long, 2-2.6 cm thick. Leaves 2, hysteranthous; petiole 27-35 cm long, 7.5-10 mm thick, deeply channelled for most of its length; lamina ovate-elliptic, 29-40-(50) cm long, (12)-16-22 (29) cm wide, acute or short-acuminate, basally attenuate to the petiole, thick, coarsely undulate, hypostomatic, abaxial cuticle thickly striate and non-glaucous. Scape (5)-7-9(10) dm tall, ca. 10 mm in diameter proximally, ca. 4-6 mm in diameter distally; bracts 3-(5) cm long, lanceolate. Flowers (7)-10-12 (13), zygomorphic, all reaching anthesis concurrently, more or less perpendicular to the axis of the scape; pedicels (11)-22-33 mm long, 1-2 mm in diameter; perianth (2.8)-3-4-(4.4) cm long, green in bud, yellow at anthesis, rarely orange or pink, compressed laterally giving the perianth a somewhat flattened appearance; tube sub-cylindrical, 5-7 mm long, ca. 5-6 mm wide, constricted at the ovary to ca. 3.8 mm wide, concolorous with the tepals for most of its length, green only at the base; tepals spreading dorsally and ventrally to 23-29 mm wide, recurved and sometimes stained green apically; outer tepals (20)-23-29-(36) mm long, 5-6 mm wide, apiculate, lanceolate, keeled, 2 of them situated laterally, one dorsally; inner tepals 20-26-(34) mm long, obtuse, oblanceolate-spatulate, margins undulate at the middle, 2 of them ca. 9.5 mm wide and situated laterally above the 2 lateral outer tepals, the third one 5-7 mm wide, ventrally declinate and with the lower lateral tepals forming a pseudo-labellum. Stamens subequal, 8.5-11 cm long, filiform, long-declinate, ascendent in their distal 1/4, green; filaments dilated and connate in their proximal 2-3 mm; globose nectar glands present at the perianth throat, each 1-2 mm in diameter; anthers 5.5-6 mm long, oblong; pollen green, the exine mostly tectate-perforate. Style 10-11 cm long, green; stigma less than 1 mm wide. Ovary ellipsoid, 6.5-9 mm long, 4-4.5 mm wide; ovules 20 or more per locule. Capsule 2.5-3 cm long, 17-22 mm in diameter; pedicel 5-6 cm long; seeds numerous, blackish-brown, ca. 6.5 mm long, 1.5 cm wide. 2N = 46. Flowering July-September and December-January.

- Ecuador.** El Oro: between Santa Rosa and La Chorita, 0-100 m, Hitchcock 21139 (GH, NY, US). Chimborazo: Rio Chanchan canyon between Naranjapata and Olimpo, terrestrial in rock wall crevices, 800 m, (ex hort), Horich ISI # 214 (UC). Between Huigra and Naranjapata, 600-1200 m, Hitchcock 20638 (GH, NY, US). Cañar: valley of Rio Cañar near Rosario, 960 m, Prieto CP-18 (NY, S). Azuay: Road from Jiron to Pasaje, near Uzhcurrumi, dry, steep, rocky hillside, 840 m, Plowman et al. 4600 (GH), Plowman 7634 (F), Plowman 12024 (F). Km 97 on road from Cuenca to Saraguro, dry thorn scrub, ca. 1100 m [incorrectly typed on specimen label as 2400 m], Madison et al. 7517 (SEL). - Inhabiting semi-desert and dry, rocky canyons and hills of the lower inter-Andean valleys (100)-300-900-(1100) m. Endemic.
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  7. Figures preferably should be cited in numerical order in the text as follows: Fig. 1, Fig. 2, etc.; tables as Table 1, Table 2, etc. Figure captions should be provided for all figures at the end of the manuscript. If high quality digital scans of figures can be sent, this is preferred. Scans must have a minimum resolution of 1000 DPI, regardless of size.
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NOTES

## NOTES



## NOTES



